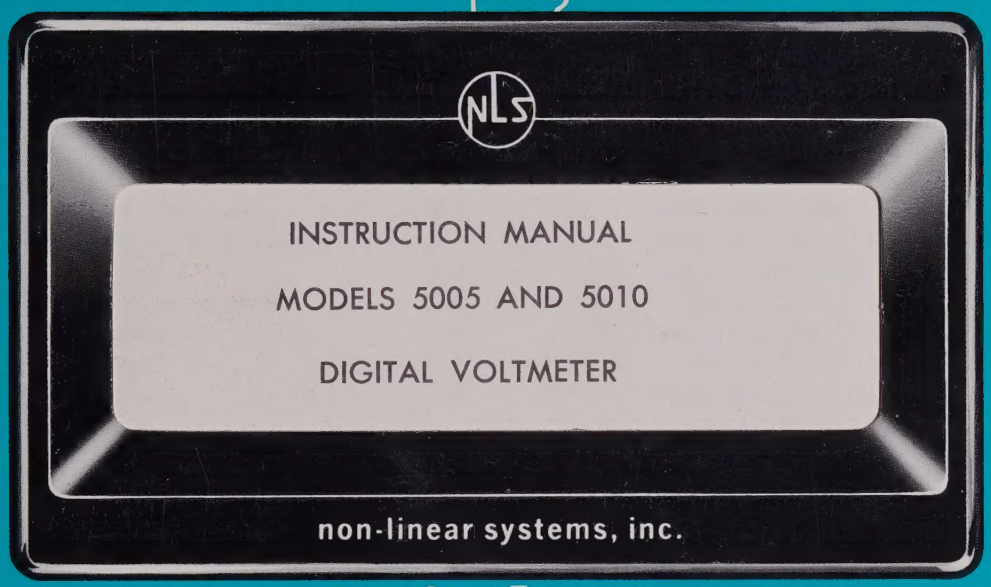


non | linear systems, inc.

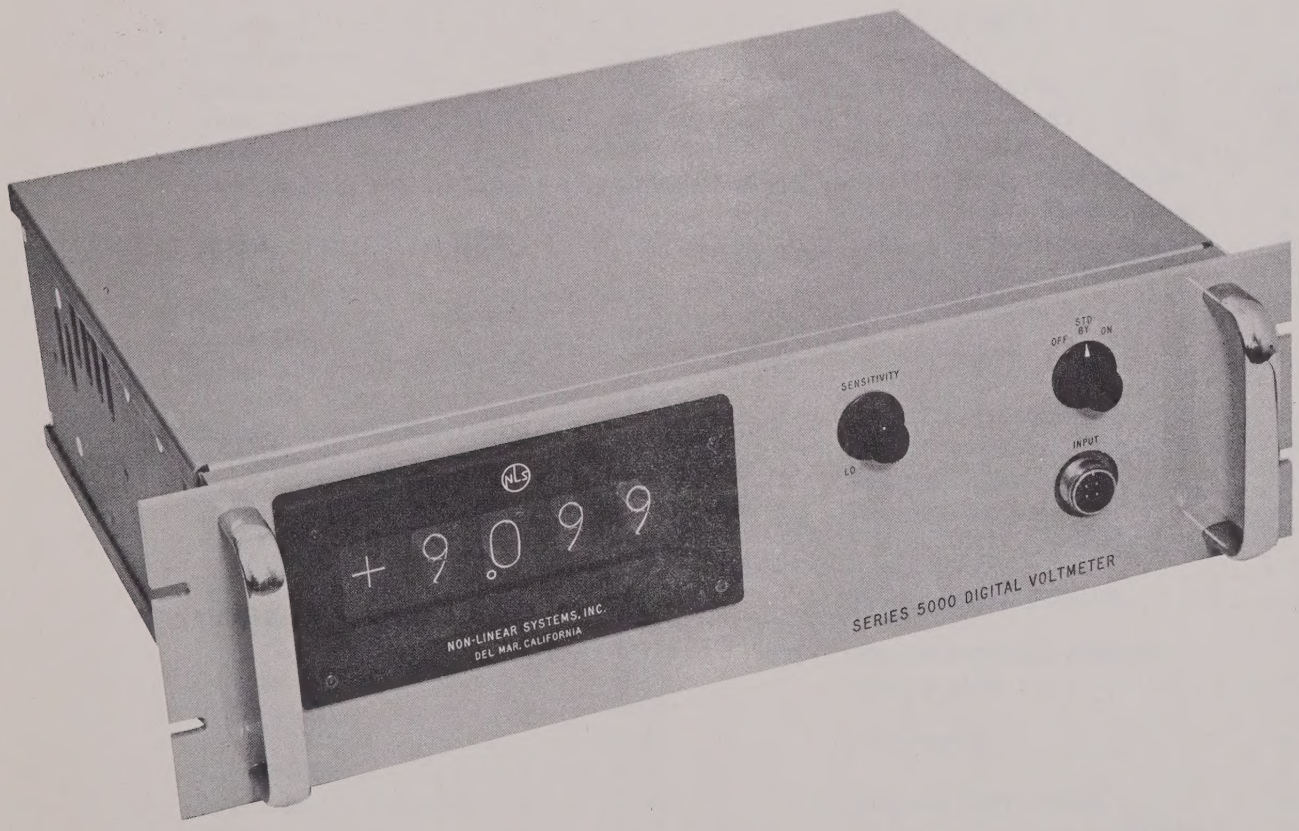
DEL MAR, CALIFORNIA

Document No. 600C
Revised July 1968

INSTRUCTION MANUAL

MODELS 5005 AND 5010

DIGITAL VOLTMETER



This manual is for instrument Serial No._____

Originator of the Digital Voltmeter

non-linear systems, inc.

DEL MAR , CALIFORNIA

Printed in the United States of America

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CHAPTER I

INTRODUCTION AND SPECIFICATIONS

The NLS Models 5005 and 5010 Digital Voltmeters are designed for users who require a highly accurate, easily-maintained instrument possessing a high order of reliability.

Although presented in greater detail elsewhere in this manual, the leading particulars of these instruments are here summarized to illustrate how NLS has met user demand, and to familiarize the reader with the instruments.

ACCURATE AND STABLE

For maximum accuracy and stability, each model, 5005 or 5010, operates as an automated version of the laboratory potentiometer, the most accurate voltage measuring device. Using a relay-operated digital feedback voltage divider, energized by a 10-volt Zener reference voltage, this instrument creates a precision feedback voltage equal to the unknown input. The feedback and unknown input are continually compared by an error amplifier which, should a difference occur, issues commands to reposition the feedback voltage divider. Operation on the 100-volt and 1000-volt ranges is achieved by an automatically-operated attenuator which divides the unknown input by 10 or 100 respectively. Ultra-stable, carefully matched and aged Zener diodes provide the self-balancing digital potentiometer excitation voltage. A temperature-controlled oven is not required.

EASY TO SERVICE

Virtually all components are mounted on plug-in circuit boards for easiest access and replacement. It is thus possible to keep the Models 5005 and 5010 operative with a minimum of down time. Hours spent in troubleshooting activities are now replaced by minutes spent in module replacement. For example, logic and feedback voltage generator circuits common to any one decade (readout window) are mounted on a separate board and these four decade boards are completely interchangeable within the instruments.

NOTE

The total interchange of decade boards fully applies to the Model 5005; however in the Model 5010, the mating connector for decade 4, on the Main Board Assembly, will not receive the decade 1, 2, or 3 boards.

COMMON-MODE REJECTION

Rejection of common-mode signals, those caused by AC or DC currents flowing between signal source ground and instrument case ground, is a key feature of the Models 5005 and 5010 Digital Voltmeters. Common-mode signal rejection is important in a wide range of applications - testing complex electrical and electronic systems, in automatic measuring systems, and measuring outputs from thermocouples, strain gauges and other transducers where common-mode signals may be many times greater than the measured DC voltage.

In the Models 5005 and 5010, 60 CPS common-mode signals of 106 DB (minimum) will have no effect upon measurement accuracy even with up to 1,000 ohms source unbalance in either side of the input line. This feature is attained because the measuring circuits are isolated from the outer case by a metal guard shield that breaks the common-mode current loop and because the power supply is isolated from the power line.

FLOATING INPUT

Because input signal leads are not connected to the 5005 and 5010 instrument's outer case, signal-to-case potentials up to 500 volts are tolerable. Floating input adds to the unit's versatility by permitting it to measure voltage sources which could not be accurately measured by a non-isolated meter.

PRINTED CIRCUIT BOARDS

Epoxy fiberglass, rather than phenolic printed-circuit boards, are used throughout the instrument to minimize circuit breakage caused by expansion and contraction. For additional mechanical and electrical stability, the Printact relays used in the instruments are mounted on individual circuit boards. These small relay boards are not subject to many of the mechanical stresses which act upon the larger component boards, and therefore, the relay contact surfaces are more likely to stay in alignment. Electrical contact quality is assured, not only by alignment, but also by the use of precious metal contact surfaces on both the printed circuit board and the relay contacts.

DIGITAL READOUT

The readout is the time-proven NLS lucite-panel, edge-lighted type in which each decade is housed in a separate module. The lamps used in this readout have been expressly designed for use in NLS readouts to combine high brilliance with long life. Since the lamps operate at transistor voltages, there is no electrical shock hazard to the user.

DIGITAL OUTPUT

The standard Models 5005 and 5010 do not provide digital output connections, however, since many users desire this optional capability, information for Printout function is provided in this manual. See figure 1-2; Chapter III, Theory of Operation; and Schematics 50-67 and 50-77.

The NLS Sales Representatives or Engineering Department will be pleased to assist you with specific application problems and, of course, will gladly welcome your comments and suggestions. A contact with the nearest NLS office or to the main office in Del Mar, California will bring prompt response.

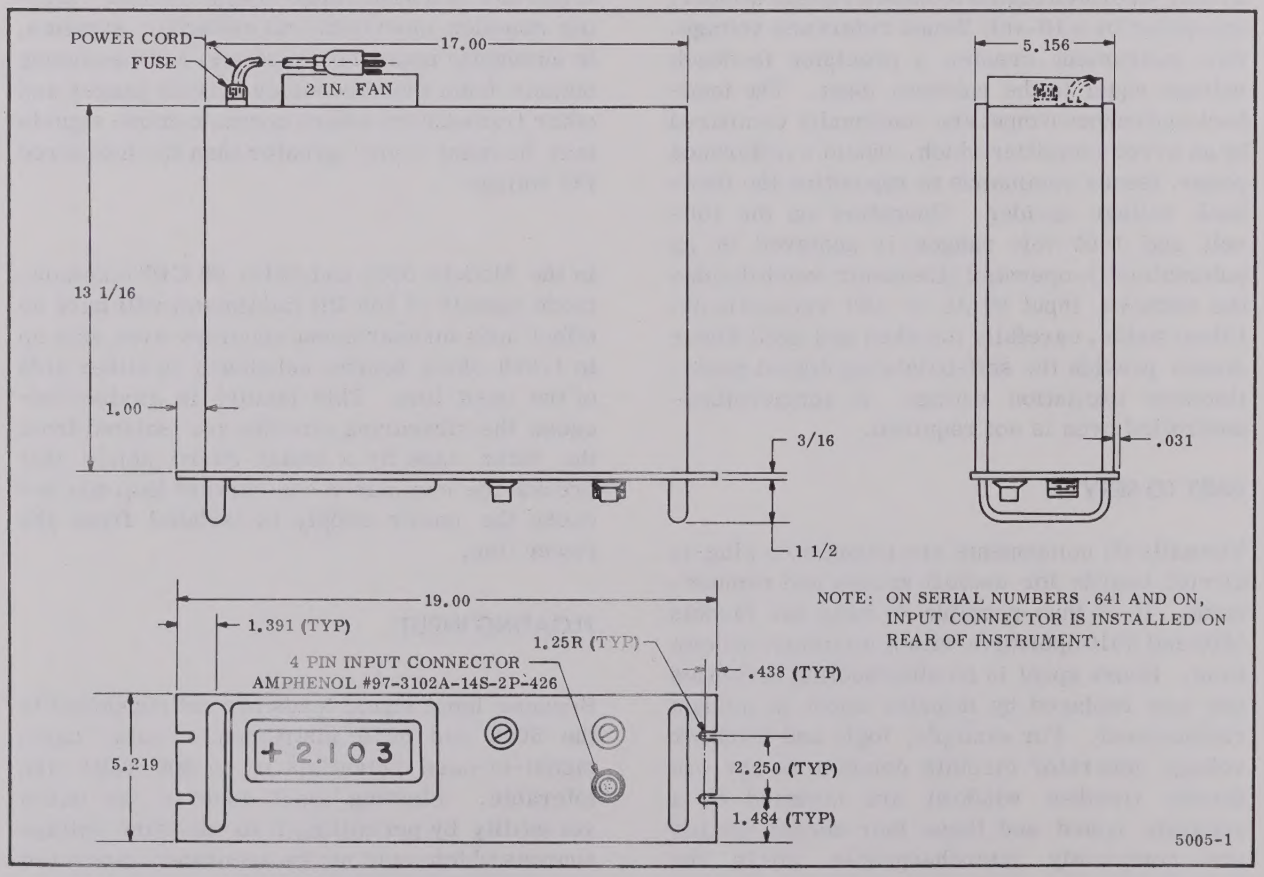


Figure 1-1. Dimension Diagram

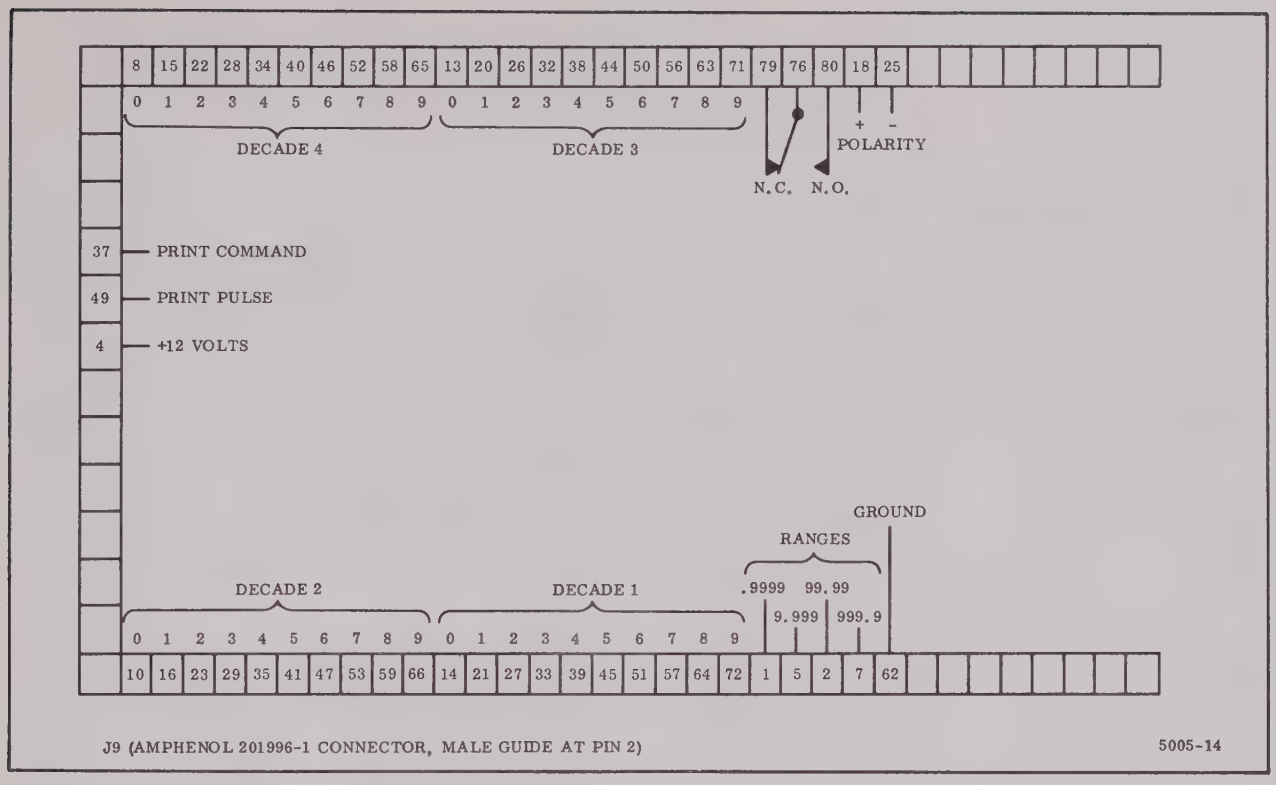


Figure 1-2. Digital Output Connections

SPECIFICATIONS

RANGES:	±9.999/99.99/999.9 volts DC for Model 5005. Model 5010 has an additional ±.9999 V range. AC measurements, ohms, and DC measurements to ±10 V can be made using accessory NLS 1100 or 1200 Series Converters or NLS Model 1401, 140, or 144 Amplifiers.
RANGE & POLARITY SELECTION:	All ranges and polarity are automatically selected; the instrument will switch itself to the range required by the input signal value. The readout displays the polarity of the high (red wire) side of the input.
SPEED:	Average: under 600 millisec/reading. Worst Case: with range and polarity change: 2 sec/reading. Best Case: approximately 0.02 second per digit increase in rightmost window.
ACCURACY:	±(0.01% of reading +0.01% of full scale)
INPUT RESISTANCE:	10 megohms

COMMON MODE REJECTION:	106 DB, minimum at 60 CPS with 1000-ohm source imbalance.
SIGNAL MODE NOISE REJECTION:	30 DB, minimum at 60 CPS.
INPUT CONNECTION:	Amphenol type 97-3102A-14S-2P-426 connector is used on the DVM. The mate is Amphenol 97-3106A-14S-2S-426. The input signal pair is not connected to outer box; signal low is isolated from inner box (See figure 2-3). Input can float to 500 volts difference between inner and outer cases.
REFERENCE VOLTAGE SOURCE:	Internal, matched Zener diodes provide the digital potentiometer excitation voltage. Temperature control with an oven is not required.
DIMENSIONS:	5-1/2" high, 13" deep (excluding connectors and fan), 19" wide.
WEIGHT:	Approximately 34 LBS.
POWER SOURCE:	115 volts, 50-60 CPS, 60 watts maximum power consumption. For 230 volt operation, the two primary windings of the power transformer must be wired in series instead of in parallel.

Specifications are Subject to Change Without Notice

CHAPTER II

INSTALLATION AND OPERATION

UNPACKING

The instrument is shipped in a two-piece polystyrene-bead container. Cut the tape between the container halves and open. If damage is seen, promptly notify the carrier. No packing materials are used inside of the instrument and it is ready for use when taken out of the shipping container. It is suggested that the container be saved if the instrument is to be stored or shipped.

POWER SOURCE

The instrument is usually supplied for operation from 115-volt, 50-60 cycle, single phase power sources. However, the instrument will operate from 220-230 volt, 50-60 cycle, single phase sources if the two primaries of the power transformer are wired in series instead of in parallel. The Serial No. tag at the rear of the instrument indicates the correct power source if other than 115 volts or 50-60 cycles.

FUSING

The instrument is protected by a 3AG one ampere slo-blo fuse which is located in an extractor post on the rear panel. When a 220-230 volt power source is to be used (and the power transformer primary rewired as indicated above), it is recommended that a half-ampere fuse be used to provide maximum protection. Keep in mind that the cooling fan is rated at 115 volts AC and must be paralleled with one winding of the power transformer pin connections when adapting the instrument to 230-volt operation.

POWER GROUNDING

The third pin of the power plug grounds the outer chassis of the instrument (figure 2-1). The internal guard shield box has no connection with power ground.

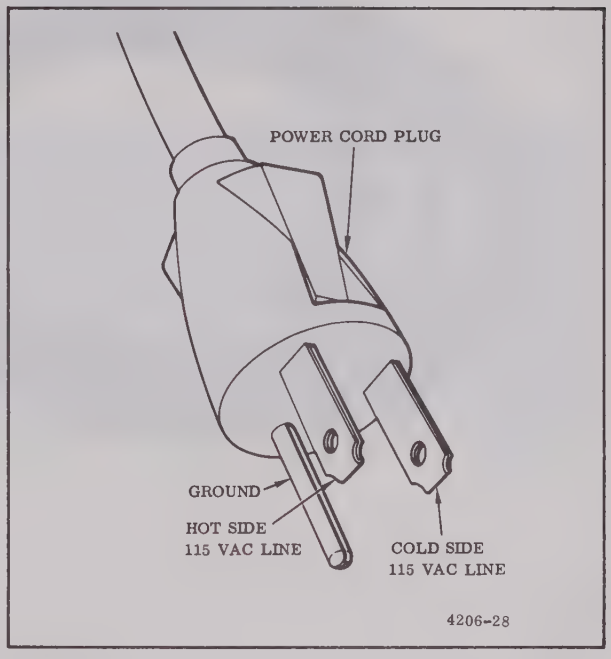


Figure 2-1. Power Plug Pin Coding

CABLES

The instrument is supplied with an input cable (figure 2-2). See figure 2-3 for connection information. The banana plugs on the cable are color coded:

Pin A - red plug - signal high
Pin B - black plug - signal low
Pin C - yellow plug - inner guard shield of DVM
Pin D - blue plug - outer case of DVM

CONTROLS

The power switch is provided to supply to and remove a current from the instrument and to allow a warm-up position (STANDBY).

The SENSITIVITY switch is provided to decrease sensitivity for noisy signals.

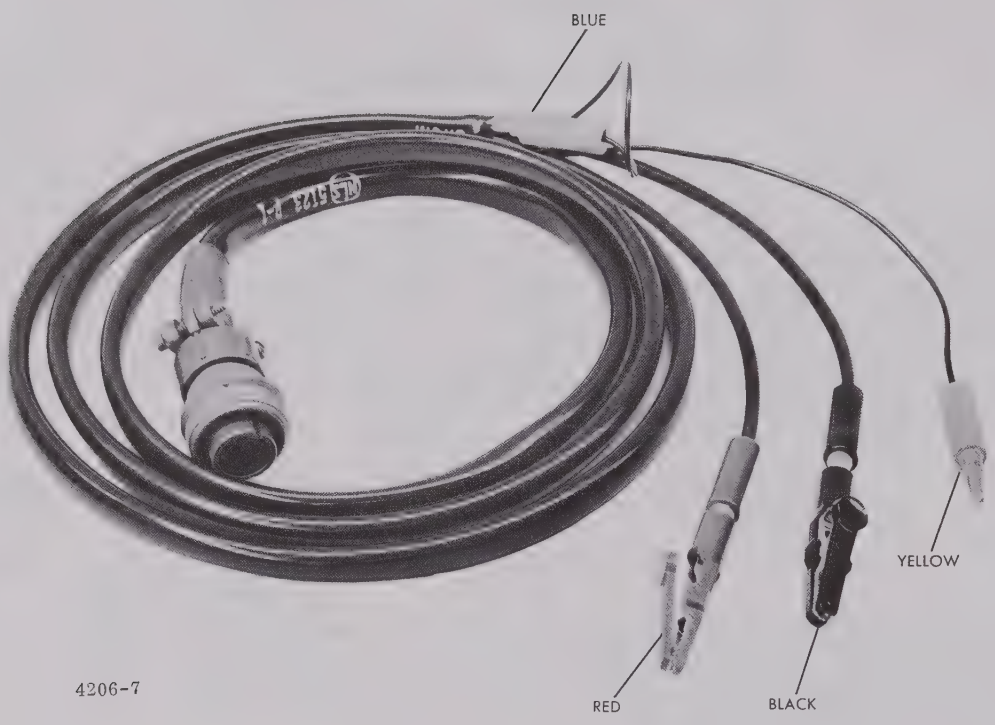


Figure 2-2. Input Cable

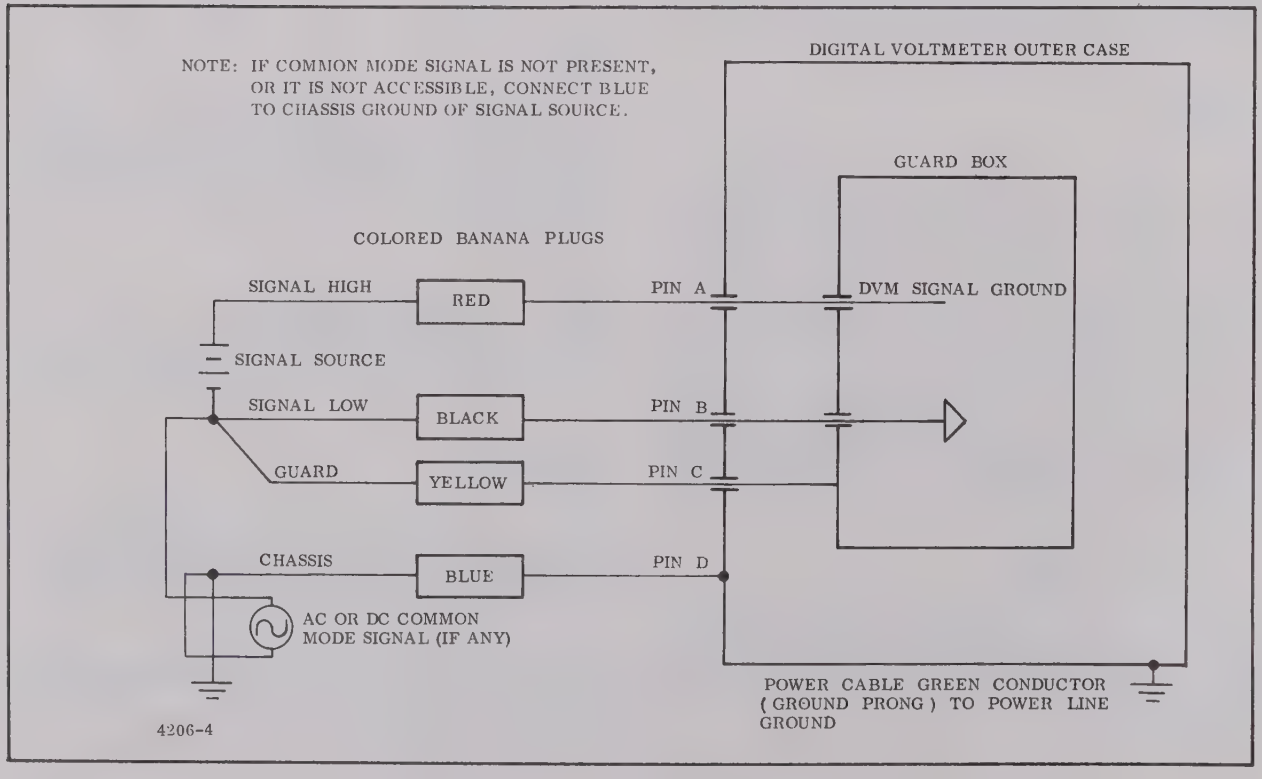
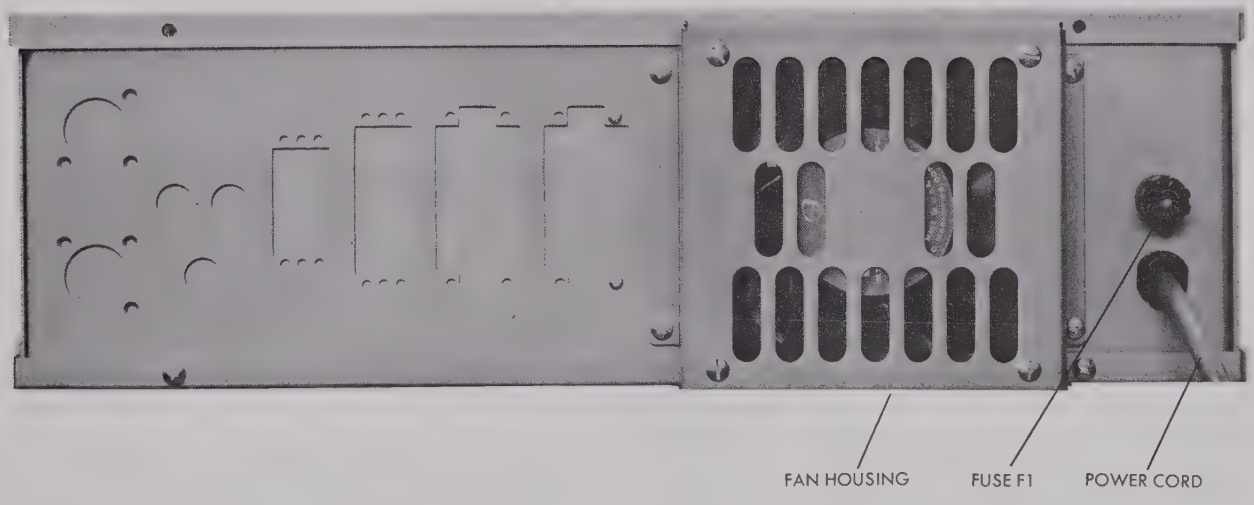


Figure 2-3. Input Connectors

ON SERIAL NO. .641 & ON,
INPUT CONNECTOR IS INSTALLED
ON REAR OF INSTRUMENT.

5005-4



5005-5

Figure 2-5. Rear View

CHAPTER III

THEORY OF OPERATION

A simplified block diagram of the Models 5005 and 5010, showing signal flow paths among the major functional blocks, will be found in figure 3-1. Schematic diagrams of each printed circuit board assembly and the main board assembly wiring diagram will be found in numerical sequence at the end of this manual.

BASIC THEORY

When a DC signal voltage is applied to the input connector of the instrument, it is impressed across a 10-megohm range divider. In the Model 5005, if the signal is between zero and 9.999 volts in value, and the range divider is set in the 10-volt range, the signal passes on to the error amplifier where it is compared with the feedback voltage. If the range divider is set in either the 100-volt or 1000-volt range, the unit will automatically down-range to the 10-volt range. In the Model 5010, if the signal is between zero and .9999 volts in value, and the range divider is set in the 1-volt range, the signal passes on to the error amplifier where it is compared with the feedback voltage. If the range divider is set in either the 10-volt, 100-volt or 1000-volt range, the unit will automatically down-range to the 1-volt range.

The DC signal input, within the error amplifier, is compared potentiometrically with the feedback voltage which is derived from a precision resistance bridge of four decades, automatically controlled by counters and relay logic. The four decades divide down a precision reference voltage of 10 volts to steps of one millivolt each. Threshold circuits in the error amplifier sense when the signal input and the feedback voltage differ by one millivolt or greater. If the signal input is greater than the feedback voltage, up-pulses are generated. If it is less, down-pulses are generated.

These pulses are routed through a polarity switch and into the counting decades through the associated decades relay logic. Relay logic determines when the count of either up- or down-pulses is transferred to the following decades. Relay logic also controls the resistance decades.

Up-pulses cause the counting decades to advance in count and the precision voltage divider output (feedback voltage) to increase. Down-pulses reset the counting decades to zero and cause the feedback voltage to go to zero. Relay logic is arranged so that up-pulses are routed through decade 1 first and then on to decades 2, 3, and 4 as required. Down-pulses cause the decades to reset to zero (both digital display and feedback voltage) in a logical sequence, always starting with decade 1. Thus, the relay logic allows the DVM to generate a precision feedback voltage in a logical fashion until it equals the DC signal input voltage within a resolution of one millivolt.

Polarity control is accomplished by means of a polarity flip-flop and two polarity relays. One polarity relay inverts the reference, the other interchanges the up- and down-pulse lines. A polarity trigger from the relay logic sets the polarity flip-flop whenever a change in polarity is required. This will occur when all decades have been reset to zero and down-pulses continue to be generated. The first down-pulse, after all decades have been reset to zero, becomes the polarity trigger.

The range divider is designed to attenuate the DC signal input by x10 and x100 for the Model 5005 and x10, x100 and x1000 for the Model 5010 as required. It is controlled by down-ranging logic, range flip-flop 1, range flip-flop 2 and a range decode matrix. The range flip-flops require two signals, up-range trigger and down-range reset. The range flip-flops and decode matrix select one of the three range conditions; i.e., 10V, 100V, or 1000V range on the Model 5005. On the Model 5010 the range flip-flops and decode matrix select one of the four range conditions; i.e., 1V, 10V, 100V, or 1000V range. Buffers are used to drive range relays and decimal lamps. Down-ranging logic senses

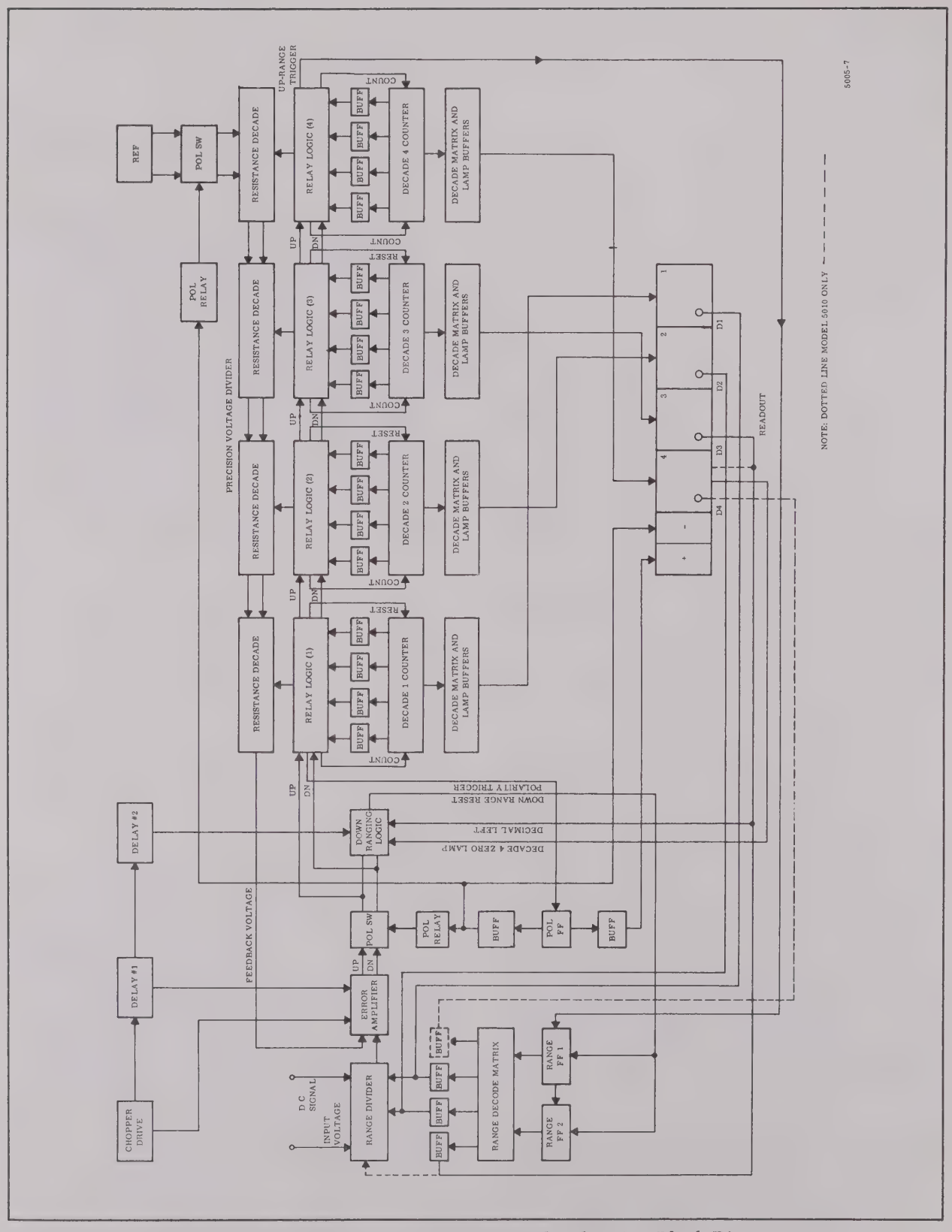


Figure 3-1. Models 5005 and 5010 Digital Voltmeter Block Diagram

a unique set of conditions which occurs only when a lower range setting of the range divider is needed. It then generates the down-range trigger pulse. An up-trigger pulse is generated when the decades have been driven to all nines and up-pulses continue to be generated. The first up-pulse, after the decades are all nines, becomes an up-range trigger pulse. Up-range trigger pulses continue to occur until the correct range has been selected.

Chopper drive contains the primary synchronizing circuitry which operates the electromechanical chopper in the error amplifier and sends gating signals to Delay No. 1. Delay No. 1 synchronizes the generation of up- and down-pulses with chopper timing. Delay No. 2 receives gating signals from Delay No. 1. Delay No. 2 synchronizes the generation of the down-range trigger pulses.

RANGE ATTENUATOR

The range attenuator is an automatically operated voltage divider controlled by ranging logic in the logic assembly. The attenuator and associated range relays are located on the amplifier assembly to keep signal paths between the attenuator and the error comparator as short as possible.

For the Model 5005, the attenuator consists of six NLS PW 2016 precision wire-wound resistors and two multiple-turn trimpots. See Schematic Diagram 50-115. For the Model 5010, the attenuator consists of seven NLS PW 2016 precision wire-wound resistors and three multiple-turn trimpots. See Schematic Diagram 50-64. The total resistance of the divider is 10.0111 megohms for the Model 5005 and 10.0011 megohms for the Model 5010. These values each provide a nominal input resistance of 10 megohms for the instruments.

Certain design considerations are paramount for this section of the amplifier assembly. Printed circuit layout and wiring is such that leakage from circuits carrying power supply levels to the attenuator is minimized as much as possible. Sealed range relays having high insulation resistance headers are used for range switching. The resistors are aged for stability and constructed to withstand high voltages. This area of the assembly must be kept as clean and free of organic and inorganic contaminants as is practically possible.

Range attenuator taps are selected by means of range logic in the logic assembly and range relays on the amplifier assembly. Simplified diagrams of range logic for the Model 5005 and the Model 5010 are shown in figures 3-2 and 3-3 respectively. Figure 3-4 shows relay contact connections to the attenuator. Connections of the relay contacts to the divider are arranged so that in the Model 5005 up to three ranges may be selected with two relays and in the Model 5010 up to four ranges with three relays.

RANGE ATTENUATOR OPERATION (MODEL 5005)

Range relays K4 and K5 are normally de-energized when the Digital Voltmeter is reading in the basic 10V range. The DC input voltage path may be traced through R15, R14, R20, the closed contacts of relay K4, and the closed contacts of relay K5 on to the output (see figure 3-3). The range attenuator and range relays are located on the 50-115 amplifier assembly. Range logic circuitry is located on the 50-116 logic assembly.

For operation in the 100V range, relay K4 is pulled in. The transfer of the wiper of K4 opens the 10V range path and connects the 100V tap to the divider output.

For operation in the 1000V range, relay K4 is de-energized and relay K5 is pulled in. The return of the wiper of K4 to its previous position and the transfer of the wiper of K5 opens up the 10V and 100V range paths and connects the 1000V tap to the divider output.

RANGE ATTENUATOR OPERATION (MODEL 5010)

Range relays K3, K4 and K5 are normally de-energized when the Digital Voltmeter is reading in the 1V range. The DC input voltage path may be traced through R15, R14, R20, the closed contacts of K3, the closed contacts of K4, and the closed contacts of K5 on to the output. The

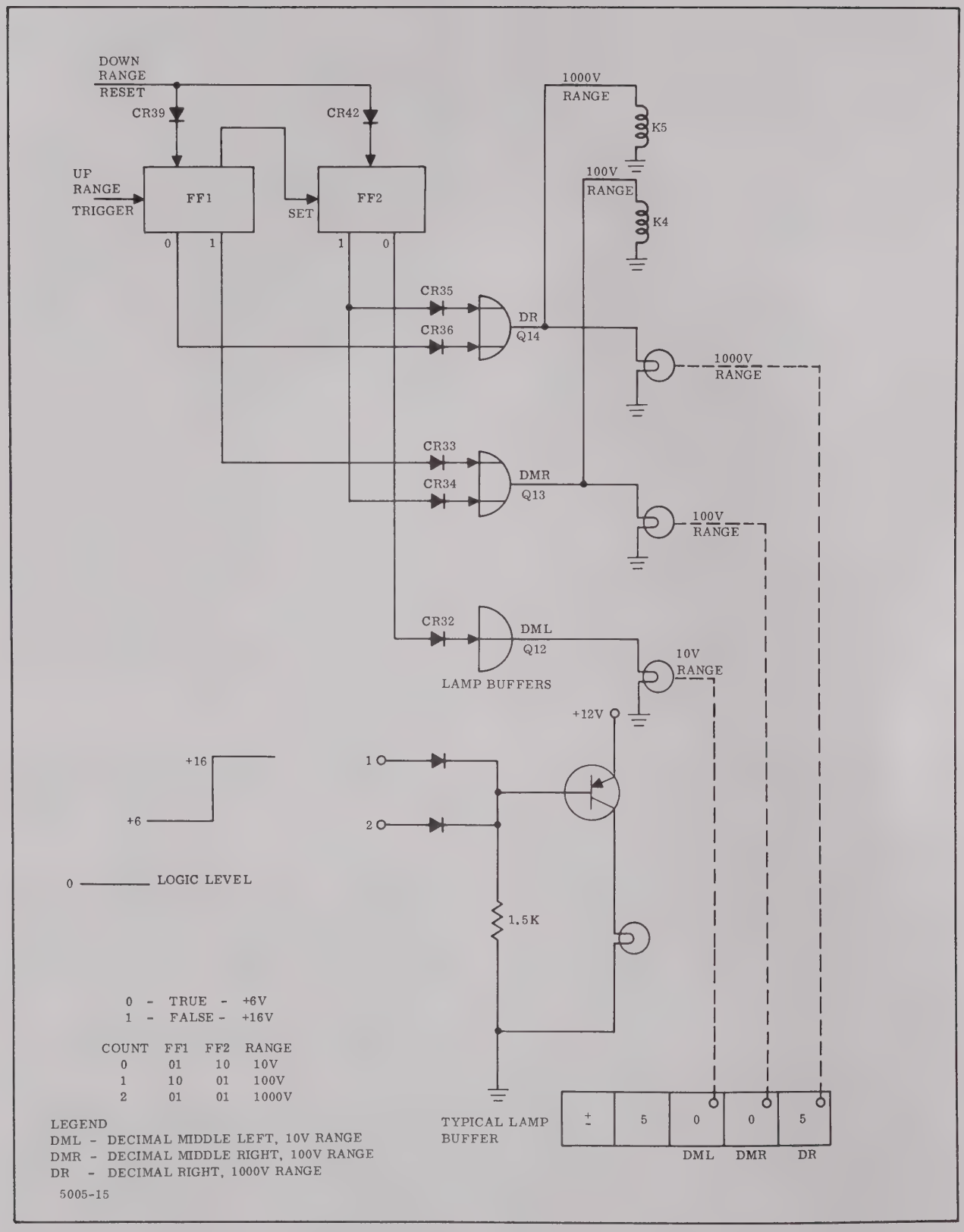


Figure 3-2. Model 5005 Range Logic Simplified Schematic Diagram

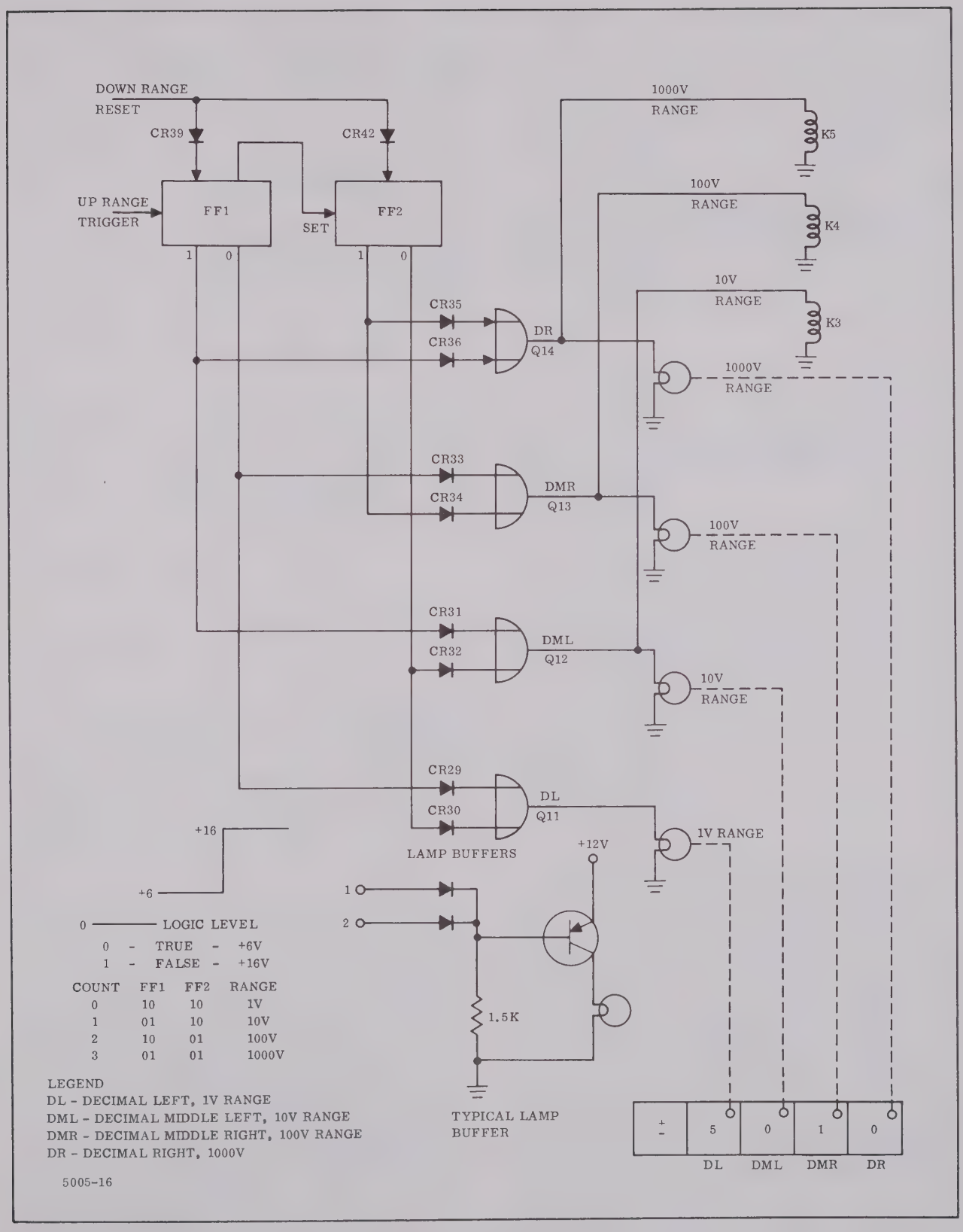


Figure 3-3. Model 5010 Range Logic Simplified Schematic Diagram

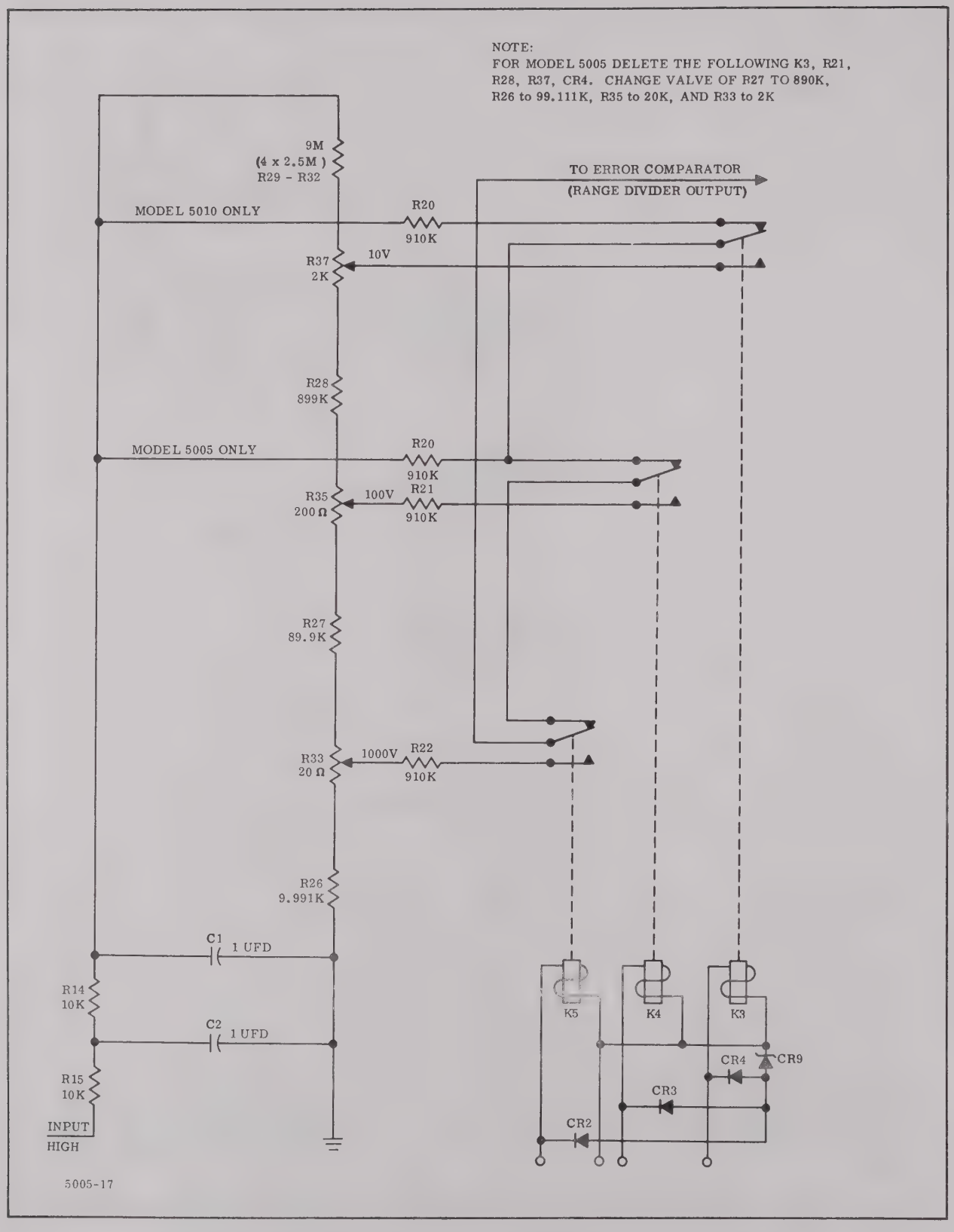


Figure 3-4. Attenuator Relay Contact Connections Schematic Diagram

range attenuator and range relays are located on the 50-64 amplifier assembly. Range logic circuitry is located on the 50-72 logic assembly.

For operation in the 10V range, relay K3 is pulled in. The transfer of the wiper of K3 opens the 1V range path and connects the 10V tap to the divider output.

For operation in the 100V range, relay K3 is de-energized and relay K4 is pulled in. The return of the wiper of relay K3 to its previous position and the transfer of the wiper of relay K4 opens the 1V and 10V range paths and connects the 100V tap to the divider output.

For operation in the 1000V range, relay K4 is de-energized and relay K5 is pulled in. The return of the wiper of K4 to its previous position and the transfer of the wiper of relay K5 opens the 1V, 10V, and 100V range paths and connects the 1000V tap to the divider output.

ERROR COMPARATOR

The elements of the error comparator are shown in figure 3-5.

Error comparison is done electro-mechanically by utilizing a Bristol CH-1417-27 Synchroverter driven at a chopping rate of approximately 40 CPS. Adherence to an exact frequency is unimportant since all timing functions are synchronized to the multivibrator in the logic assembly which drives the chopper coil.

When the chopper wiper dwells on pin 2, capacitor C3 charges through 910K to a voltage level proportional to e_D, the input voltage. When the wiper dwells on pin 4, the voltage on C3 must readjust by charging or discharging, as the case may be, to the Digital Voltmeter feedback voltage level e_f. This results in a square wave voltage waveform at pin 3 having the approximate shape illustrated in figure 3-6. This waveform is differentiated by capacitor C3 and resistor R10 in the linear pulse amplifier to produce short duration voltage pulses whose amplitude is proportional to the difference between e_D and e_f.

The low frequency cutoff of the linear pulse amplifier is adjusted so that the change in voltage at pin 3 produced by the relatively slow time constant R20 · C3 is severely attenuated (when chopper wiper dwells on pin 2). The change in voltage at pin 3 produced by the fast time constant R10 · C3 is essentially not attenuated by the amplifier (chopper wiper dwells on pin 4). Only the pulse produced when the chopper wiper dwells on pin 4 is used for error sensing purposes. All phasing in the Digital Voltmeter having to do with error pulse conditioning and generation of up- and down-pulses is based on this fact.

Capacitor C4 serves as a source of charge which allows capacitor C3 to change its charge level rapidly. Resistor R19 in combination with C4 forms a simple low pass RC filter which aids in attenuating switching noise coming from the precision bridge.

The 910K resistor shown in the diagram may be either R20 or R22 (also R21 for Model 5010) in the amplifier assembly, see Schematics 50-64 and 50-115. Its purpose is to maintain essentially constant source impedance to the error comparator when the Digital Voltmeter is operating on the basic 10V range or the 1000V range. This matches the source resistance of the range divider on the 1V and 100V ranges (approximately 910K).

ERROR COMPARATOR — LINEAR PULSE AMPLIFIER OPERATION

Assume that the input from the range attenuator, e_D, is positive with respect to the Digital Voltmeter feedback voltage, e_f. (See figures 3-5, 3-6, or 3-7 as required.) When the chopper wiper dwells on pin 2, a positive-going pulse is produced at the junction of R10 and C3. This pulse is not used. When the chopper wiper dwells on pin 4, a negative-going pulse is produced. If the difference between e_D and e_f is greater than 100 microvolts, the precision bridge must be signalled to automatically adjust its output upward or in a positive direction. Following the polarity marks shown in figure 3-7, it can be seen that an amplified negative-going pulse will appear at the collector of Q5 and a positive-going pulse at the emitter of Q5.

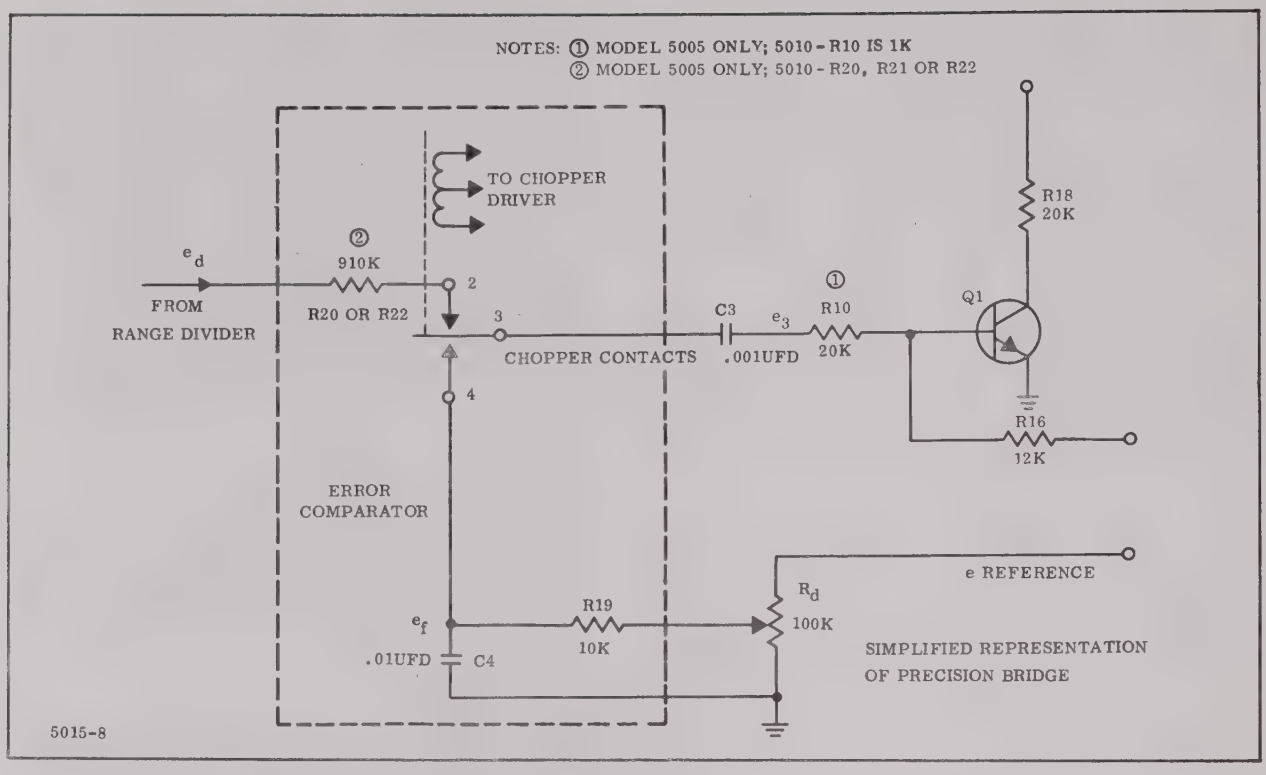


Figure 3-5. Error Comparator Simplified Schematic Diagram

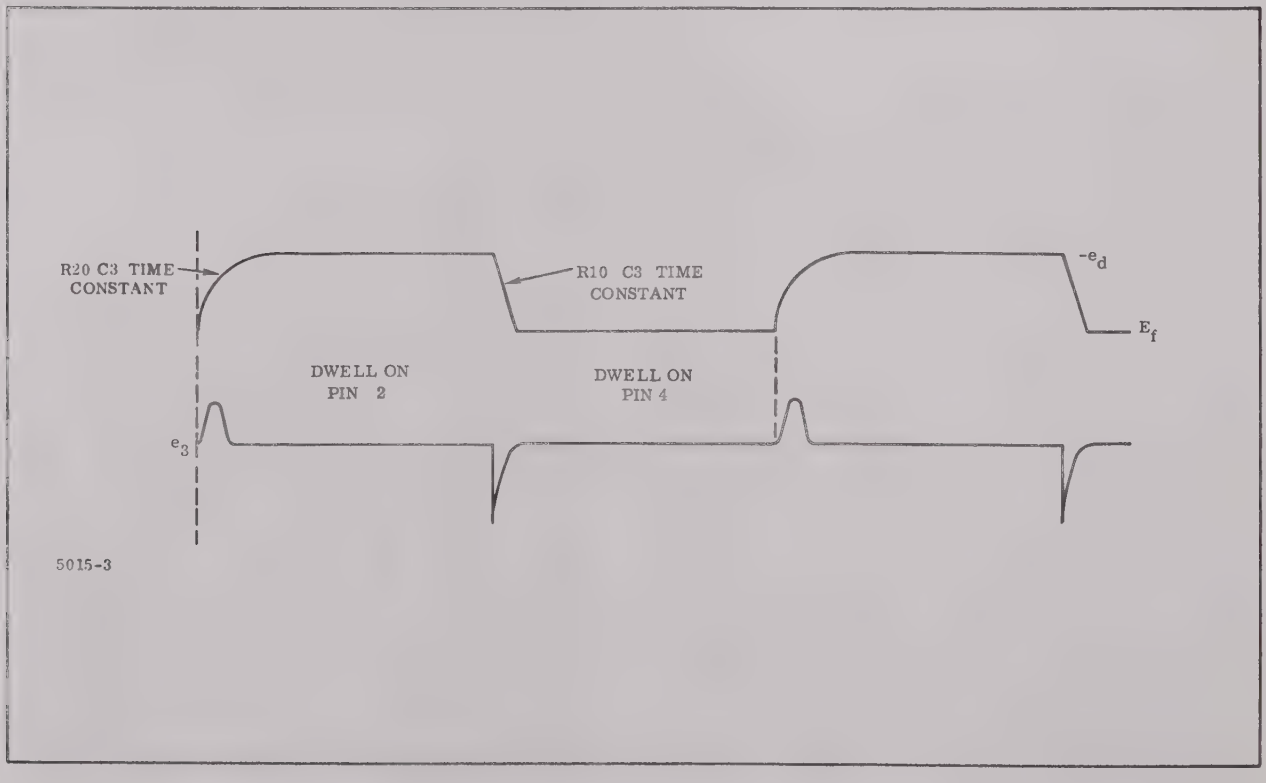


Figure 3-6. Error Comparator Voltage Waveform

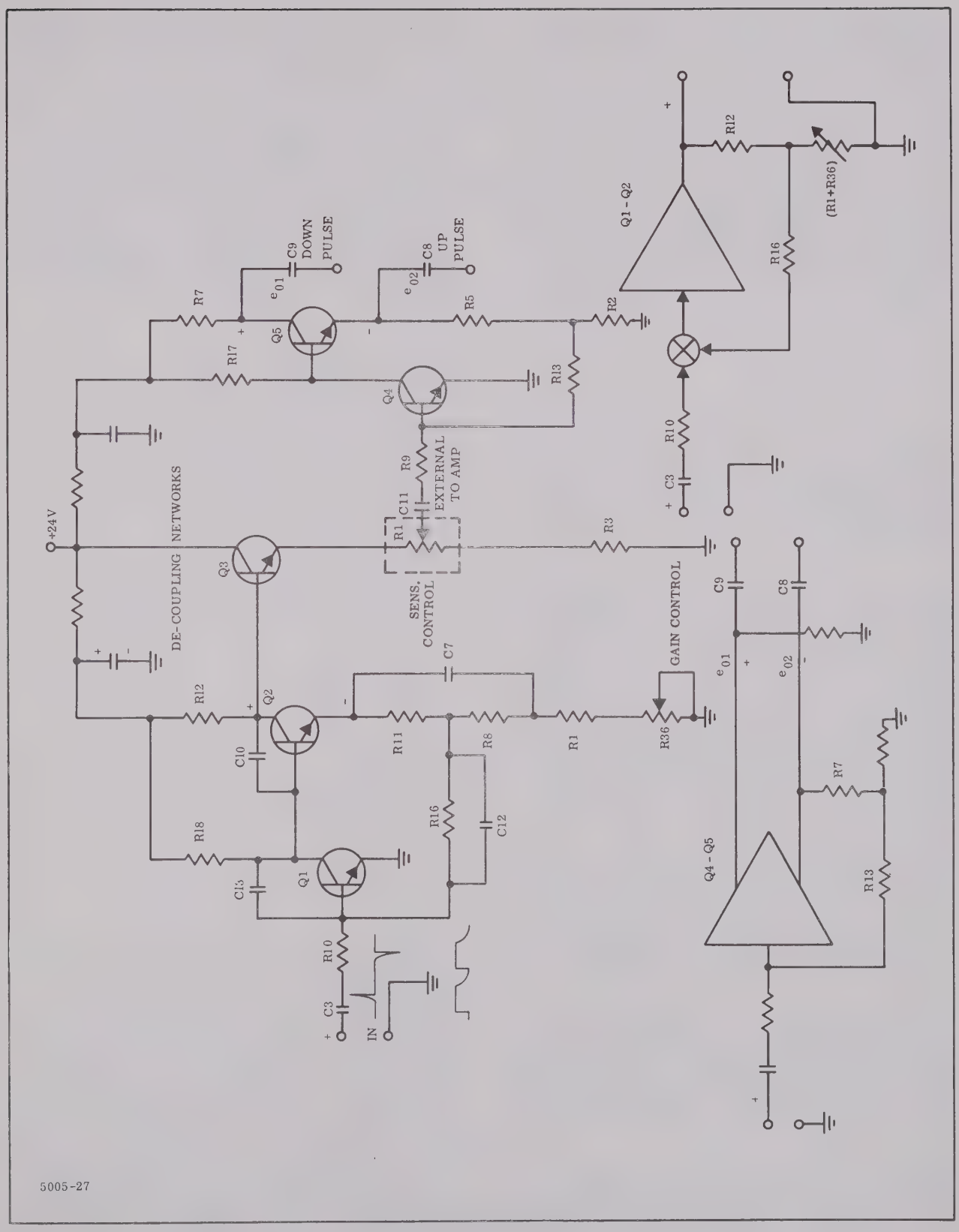


Figure 3-7. Linear Pulse Amplifier Simplified Schematic Diagram

There is a further restriction that only positive-going pulses can trigger the threshold detector circuits. Therefore the up-pulse line of the linear pulse amplifier is identified as the output at the emitter of Q5. The down-pulse line is then the output at the collector of Q5.

The transistor circuitry in the linear pulse amplifier requires a collector supply of +24 (1 VDC) at a current drain of about 20 ma. De-coupling networks isolate the transistor-feedback pairs from the common power supply impedance.

LINEAR PULSE AMPLIFIER

The purpose of the linear pulse amplifier is to amplify the level of the error signal coming from the error comparator to a magnitude of approximately one volt. One volt is the trigger level of the threshold detector circuits in the logic assembly.

The AC gain of the linear pulse amplifier is set and controlled by three feedback amplifiers. The first consists of transistor-feedback pair, Q1 and Q2; the second is an emitter follower, Q3; and the third is made up of transistor-feedback pair, Q4 and Q5. Feedback pair, Q1 - Q2, and Q4 - Q5 are similar in design except that feedback pair, Q4 - Q5 has been modified to provide a split phase output. High beta low noise silicon transistors are used throughout.

By treating the two-transistor-feedback pair as a building block, a high gain amplifier has been constructed which offers excellent bandwidth at low noise levels, midband gain predictability, and economy of components; and because of its direct-coupled arrangement, excellent bias stability.

A simplified diagram of the two-transistor-feedback amplifier is shown in figure 3-8(A). All capacitors except input capacitor C3 and emitter bypass capacitor C7 have been omitted for simplicity.

Plus and minus signs indicate instantaneous signal polarities. The circuit is further simplified in figure 3-8(B) and 3-8(C) by assuming C7 adequately bypasses R11 and R8 in the frequency range of interest and that the current gains of Q1 and Q2 are high.

The base of Q1 serves as a summing junction for the input voltage and negative feedback obtained through resistor R16. This type of connection is called parallel feedback and causes the input resistance at midband to become essentially R10. An analysis of this circuit, using conventional techniques, yields the following approximate expression for voltage gain:

$$\frac{e_o}{e_i} = \frac{R12}{R1 + R36} \cdot \frac{R16}{R10}$$

Thus the range of gains available in this section of the amplifier is as follows:

R10 = 1K R12 = 6.8K R36 = 0

R16 = 12K R1 = 30 ohms

$$\frac{e_o}{e_i} = \frac{R12}{R1} \cdot \frac{R16}{R10} = \frac{6800}{30} \cdot \frac{12000}{1000}$$

$$\frac{e_o}{e_i} = 2720$$

For R36 = 200

$$\frac{e_o}{e_i} = \frac{6800}{230} \cdot 12$$

$$\frac{e_o}{e_i} = 354$$

By adjusting R36 the gain may be varied over the range 354-2720.

DC feedback for bias-point stability is obtained from a divider consisting of resistors R11, R8, R1, and R36 in the emitter circuit of Q2. Resistor R10 does not affect DC feedback to the base of Q1 because capacitor C3 blocks any DC return path to ground. Because of this, resistor R10 may conveniently be used to change the AC gain of the feedback pair by a large amount without affecting the DC biasing of the amplifier.

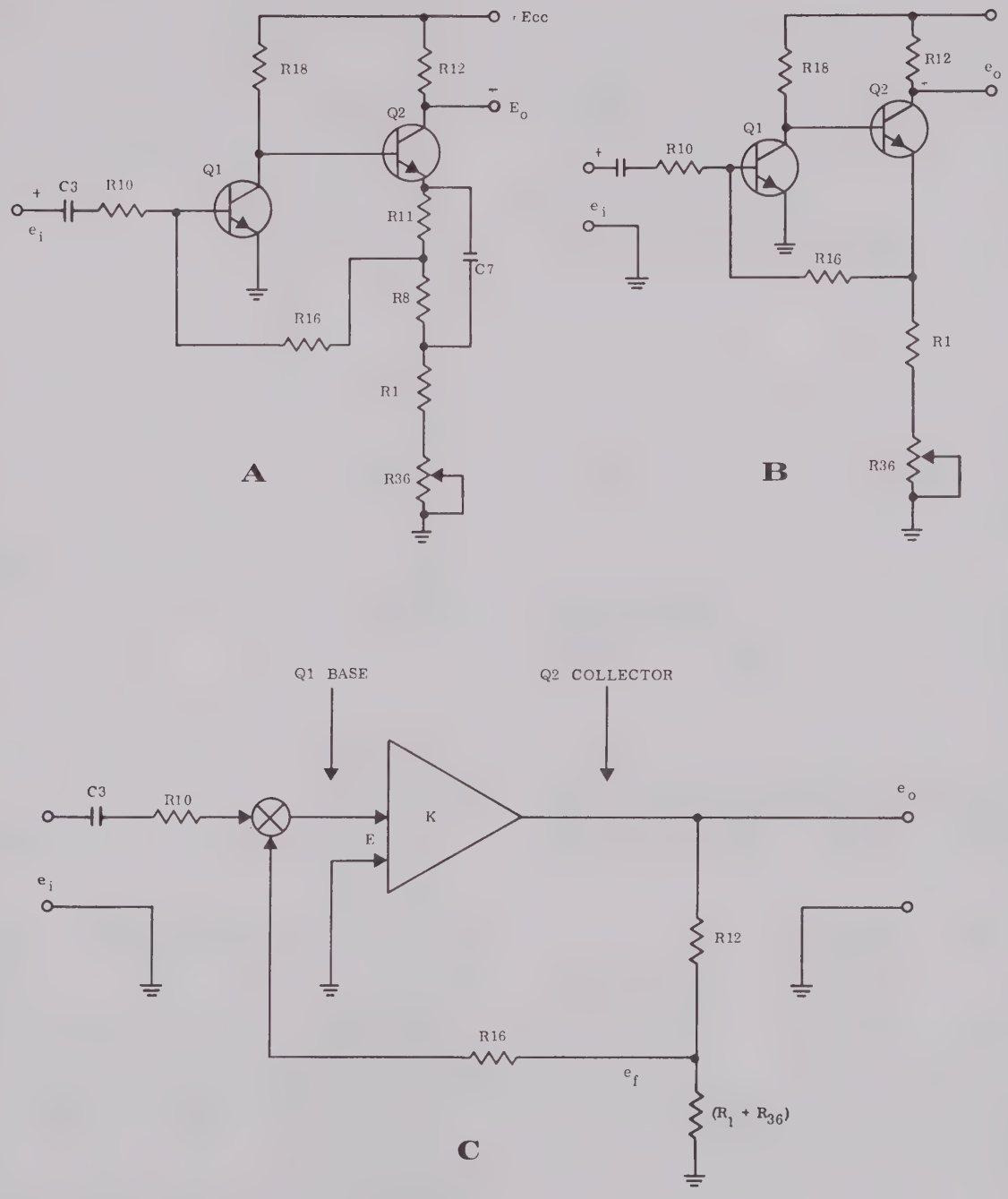


Figure 3-8. Two-Transistor Feedback Amplifier Simplified Schematic Diagram

Capacitors C10, C12, and C13 are used to roll-off the high frequency gain of the amplifier. See figure 3-7.

Transistor Q3, resistor R3 and sensitivity control R1 comprise an emitter follower which buffers the output of the Q1 - Q2 feedback pair from the input of the Q4 - Q5 feedback pair. It also provides a convenient point to insert the Digital Voltmeter sensitivity control at a higher signal level to minimize noise pickup in the wiring going to the sensitivity potentiometer R1. Its gain is unity with R1 turned fully counter-clockwise. When R1 is fully clockwise the gain is approximately

$$\frac{180}{180 + 1000} = \frac{180}{1180} = 0.16$$

Therefore this control can reduce the sensitivity of the pulse amplifier by a factor of $\frac{1}{0.15} = 6.7$. In terms of digits of sensitivity this would be about 6-7 digits.

The output stage of the Q4 - Q5 feedback pair has been altered to provide a split phase output, i.e., signals of equal magnitude, but opposite phase, are seen at the dual outputs. See figure 3-9.

Plus and minus signs indicate instantaneous signal polarities. Using conventional analysis techniques, the gain derivation for the dual outputs produced the following approximate expressions:

$$\frac{e_{01}}{e_i} = \frac{R7}{R2} \cdot \frac{R13}{R9}$$

$$\frac{e_{02}}{e_i} = \frac{R5}{R2} \cdot \frac{R13}{R9}$$

The gains are equal but opposite in phase. A typical value of gain then is:

$$\frac{e_{01}}{e_i} = \frac{360}{36} \cdot \frac{10,000}{1000}$$

$$= 10 \cdot 10 = 100$$

Thus, the product of gains of the two feedback pairs and emitter follower (with gain of unity) can vary over the range of 3540 to 27,200. This is then adequate to provide, for the Model 5005, the gain of 1000, required to raise a 1 millivolt error and for the Model 5010, the gain of 10,000, required to raise a 100 microvolt error, the basic respective sensitivities of the two instruments, to 1.0 volts. Pulses identified as up- and down-pulses are coupled from the dual output of transistor Q5 through capacitors C8 and C9 (see figure 3-7) to the threshold detection circuits in the Logic Assembly.

THRESHOLD DETECTOR

The up- and down-pulse lines are routed to two identical threshold detection circuits. The primary purpose of the threshold detector is to sense when an error pulse amplitude, corresponding to, for the Model 5005, a 1 millivolt difference and for the Model 5010, a 100 microvolt difference at the output of the error comparator, is exceeded. This amplitude is approximately 1.0 volt. In addition, the detector must raise the power level of the amplifier output to generate:

1. Up- and down-triggers for the decade counters.

2. Synchronize these triggers with the chopper drive.

3. Prevent cross-coupling between up and down channels.

4. Blank out noise generated by the chopper, logic circuits and relay logic.

The design of the threshold detector is based on the characteristics of the 3N58 silicon-controlled-switch (SCS). This thyratron-like device is similar to silicon controlled rectifiers but is designed to operate at lower power levels (see figure 3-10).

The characteristics of importance of the threshold detector are:

1. The device may be turned on by extremely low current and voltage levels at the cathode gate.

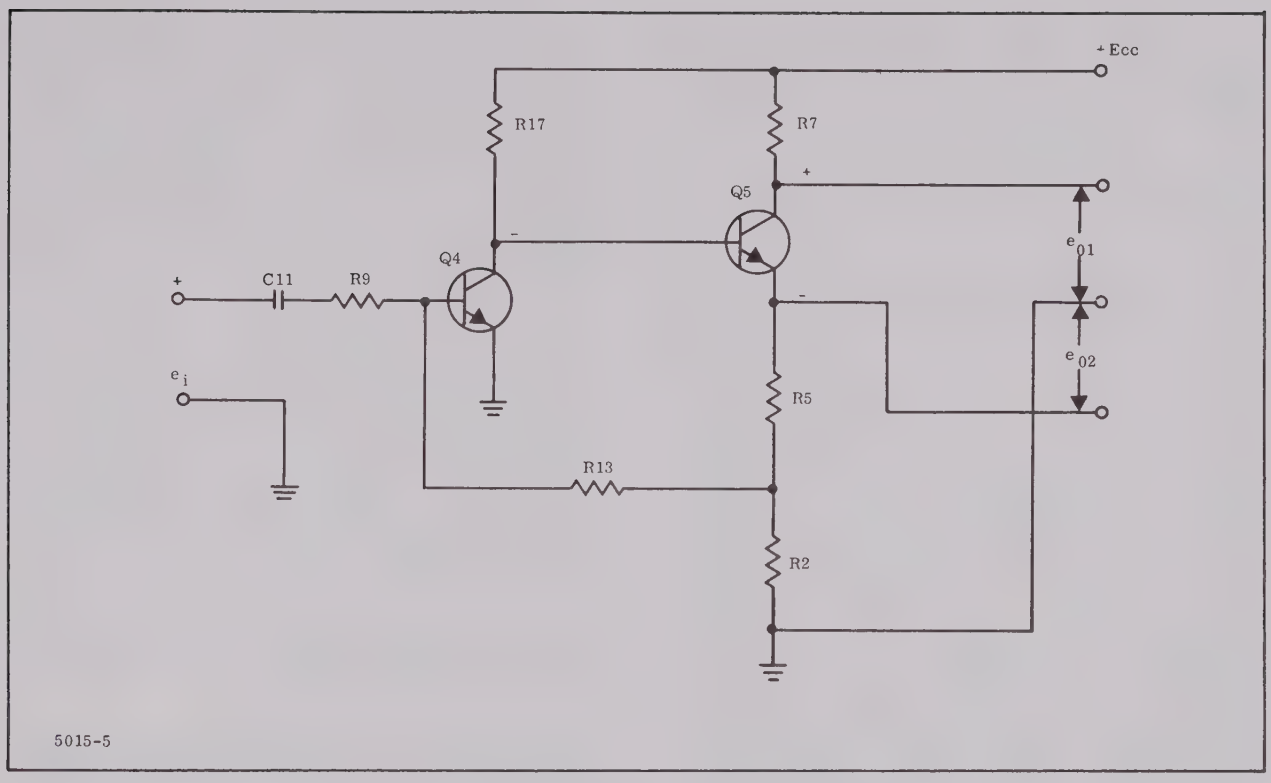


Figure 3-9. Output Stage Schematic Diagram

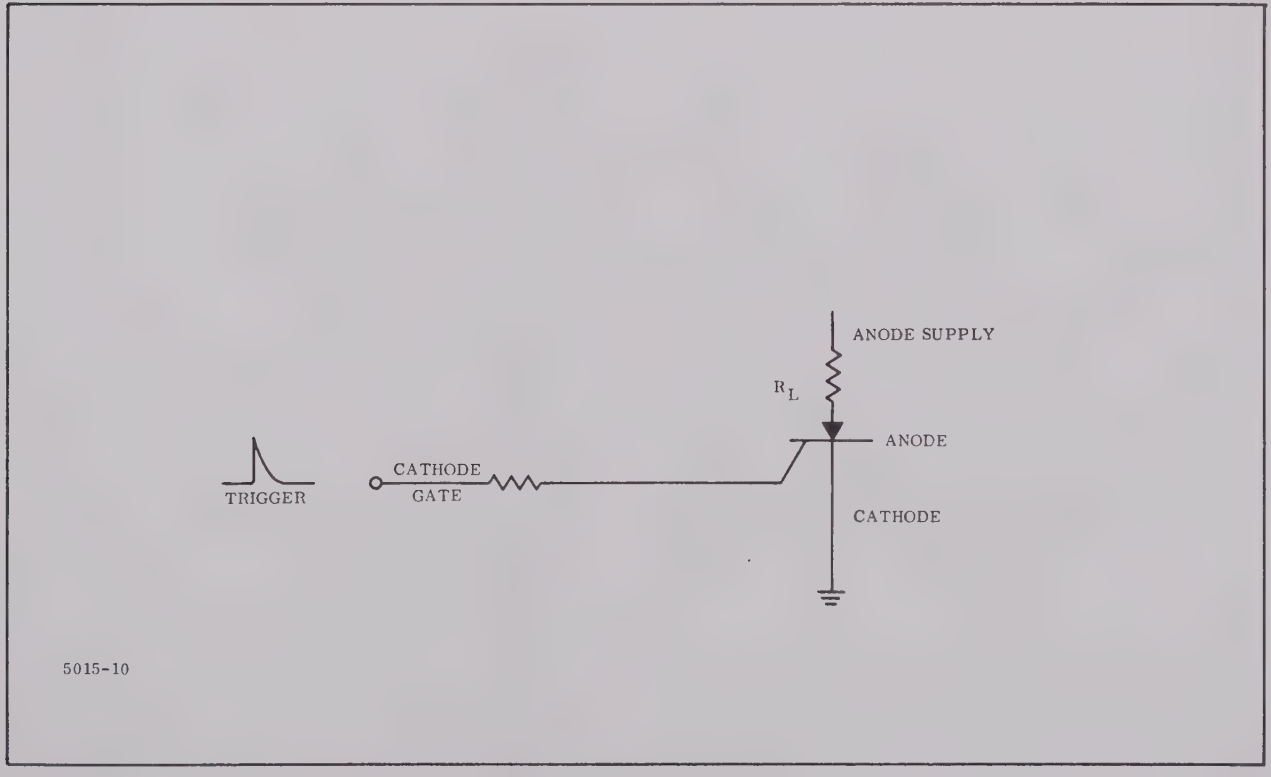


Figure 3-10. Example of Silicon-Controlled Switch Circuit

2. Once turned on, the device remains on until the anode supply is removed or the load current is reduced to a value less than the holding current of the device.

A diagram of the threshold detector is shown in figure 3-11.

The anode supply is a square wave of voltage obtained from the chopper drive circuitry. It varies between the levels of +2V and +20V.

Both Q25 and Q26 remain in a blocked state until either an up- or down-pulse of approximately 1.0 volts triggers one of them into the "on" state. The up- and down-pulses are synchronized and phased with the anode supply in such a way that the anodes of Q25 and Q26 are positive when the chopper wiper dwells on pin 4, the precision bridge feedback voltage. If Q25 is triggered into the "on" state, it saturates with a forward voltage drop of about 1.0 volt and current flows through the load circuit consisting of R20 and R3. The current is limited by the ohmic value of these resistors and by the +20 volt anode supply during one-half cycle of a clock period. The voltage drop across R3 reverse biases the cathode gate of Q26 to prevent it from being turned on by positive-going overshoots on the up-input. Thus, an important operating feature of the threshold detector is that whenever one of the silicon-controlled-switches is turned on, the other is biased off by the current flow of the "on"-switch through the common cathode resistor.

When the anode supply drops to +2V, an "on" SCS will turn off. During the half-cycle that an SCS is turned on, it cannot respond to any noise pulses at its cathode gate. When the SCS is off (anode supply at +2), it cannot be turned on by noise spikes. Figure 3-12 shows the timing relationships of the error pulses, anode supply and chopper drive (clock).

Delay No. 1 is approximately 150 microseconds. Mechanical and electrical delay of the chopper, T_c is about 300 microseconds.

The leading edge of the anode supply is delayed 150 microseconds to blank out chopper switching spikes.

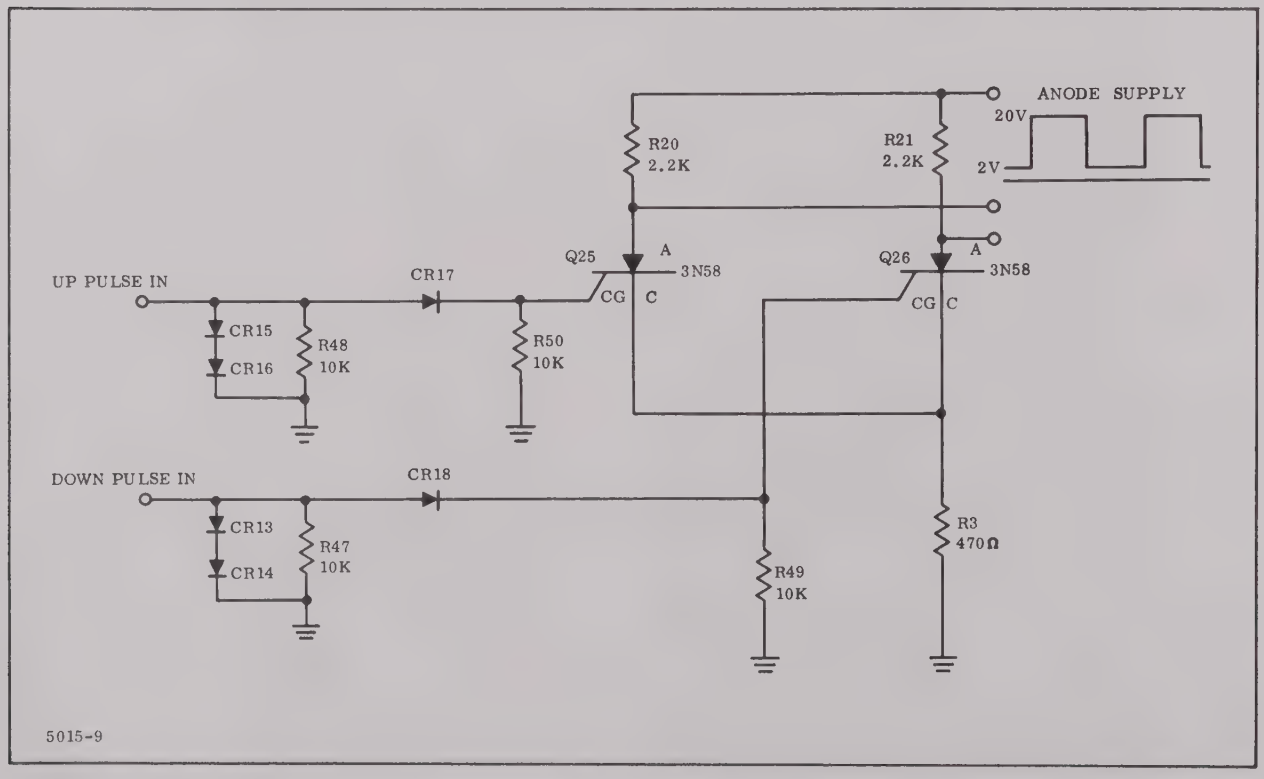


Figure 3-11. Threshold Detector Schematic Diagram

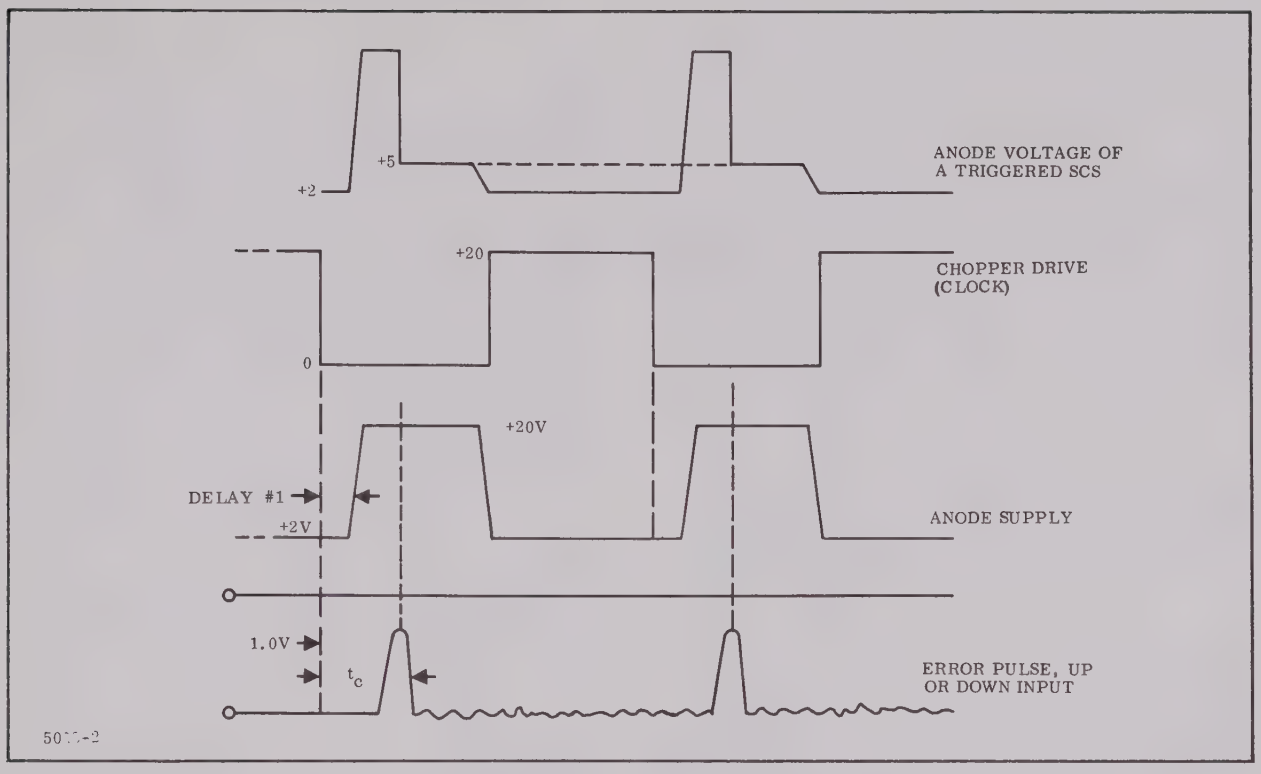


Figure 3-12. Threshold Detector Timing Diagram

Figure 3-13 is a simplified diagram showing the circuits which have been added for shaping the up- and down-signals into rectangular pulses rather than differentiated pulses. Only instruments having logic boards marked 50-70 (Ⓒ or later change letter) contain this added circuitry. The difference in timing between the waveforms of Delay No. 2 and the up- or down-outputs from Q7 and Q8 are used in conjunction with the gating circuits of Q27, Q28, and Q29 to produce a rectangular pulse. Refer to the timing diagram of figure 3-14 to see the various time relationships among the waveforms.

Transistor Q27, diode CR47, and resistors R77, R78, and R81 comprise a gate which controls the time when Q28 or Q29 can be turned on. When Q27 is off, both Q28 and Q29 are back-biased by the +24V supply operating through R78, R79, and R80. Since an up- or down-input to Q28 or Q29 does not exceed +20V there is at least a minimum of 4 volts of turn-off bias to keep these transistors off until the right time.

Transistors Q28 and Q29 can only be turned on when either of their respective emitters rises to +20V and when Q27 is saturated. When Q27 saturates, both R79 and R80 are brought to within +0.6V of ground. Also, if there is +20V on the emitter of either Q28 or Q29, it can be seen that the circuit is then in a forward-bias condition and one or the other of the transistors will turn on.

The output of Delay No. 2 is used to turn Q27 on and off. When Delay No. 2 output is positive, Q27 is turned on. The coincidence of a positive level from Delay No. 2 and a +20V level on an up- or down-line can occur only during the shaded portion of the waveform shown in waveform No. 5 of figure 3-14.

This represents the turn-on interval for either Q28 or Q29. A rectangular pulse at the collectors of Q28 or Q29, as shown in waveform No. 6 of figure 3-14 is then generated.

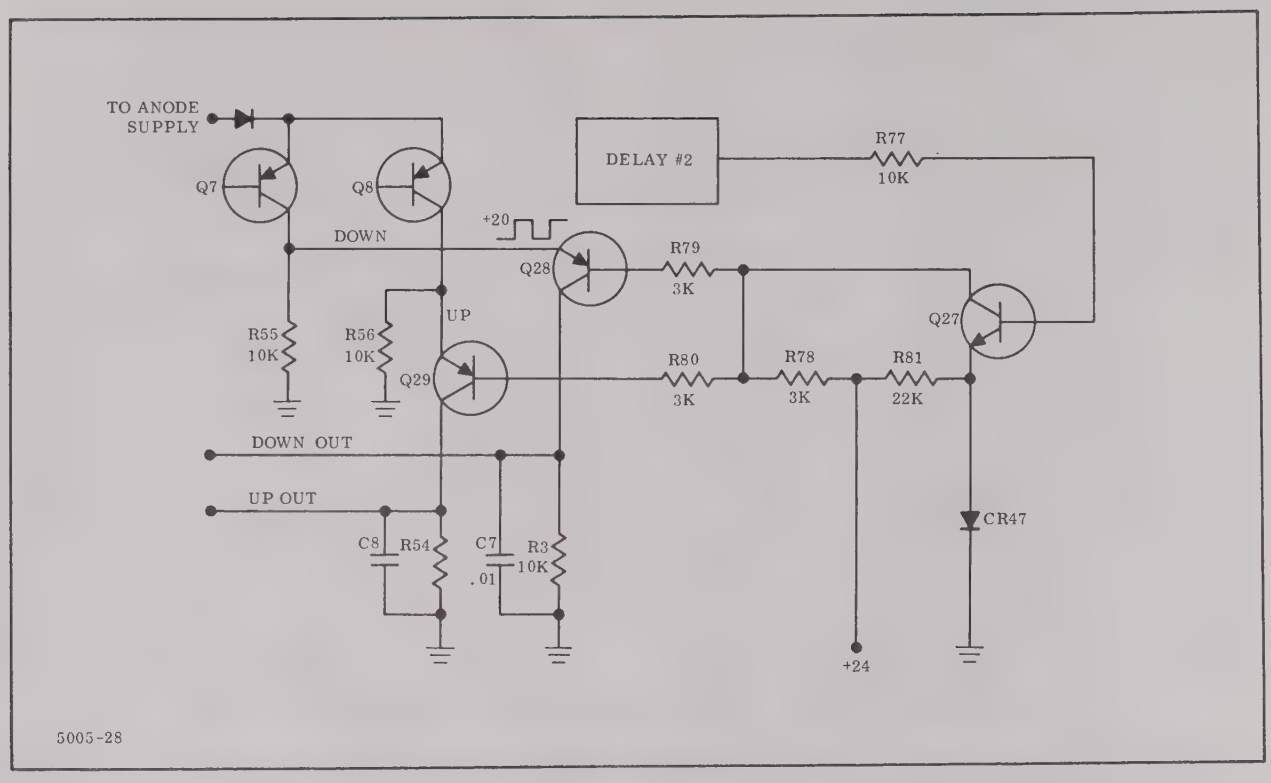


Figure 3-13. Up- and Down-Pulse Shaping Circuitry

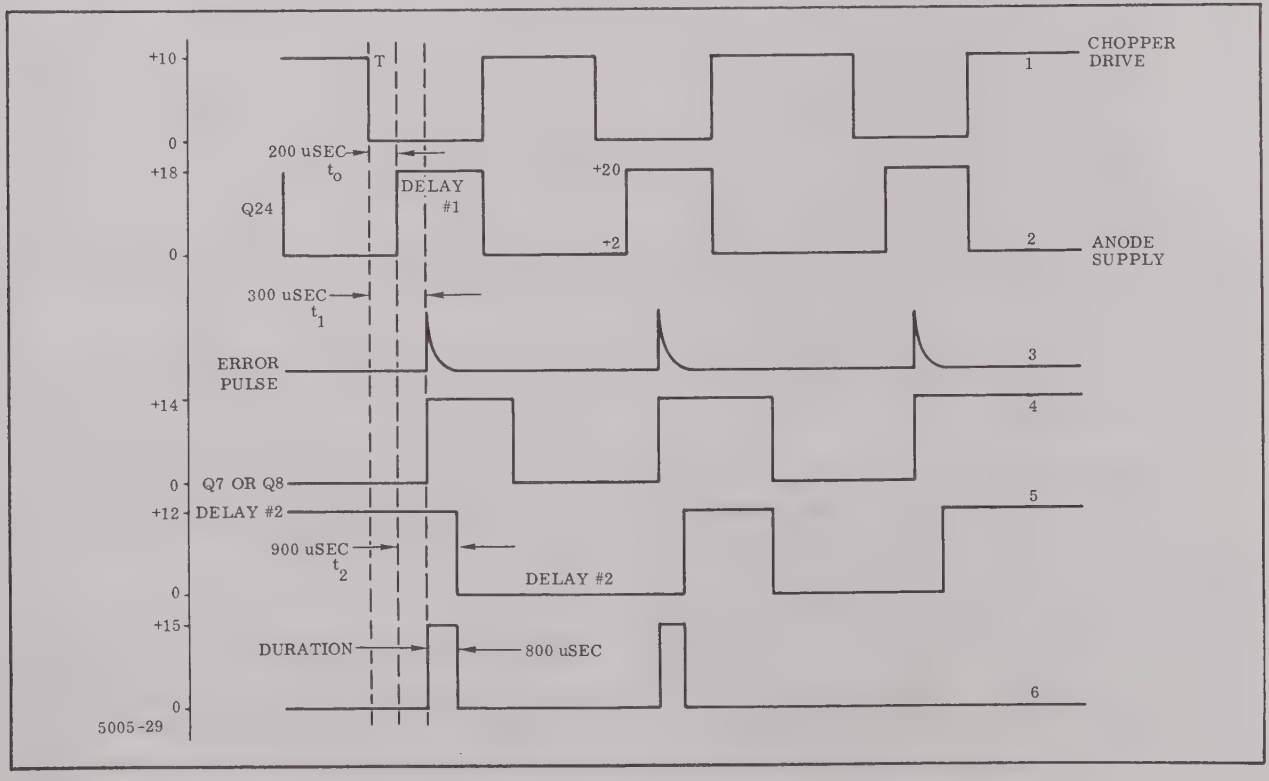


Figure 3-14. Pulse Shaping Circuitry Timing Diagram

RANGE LOGIC

Simplified diagrams of the range selection logic is shown in figures 3-2 and 3-3. Refer to Schematic Diagrams 50-72 (Model 5010) and 50-116 (Model 5005) for circuit details.

A two-stage binary counter, six-diode decoding network and three or four buffer gates are required to permit automatic selection of range and decimal point. The purpose of the counter, decoding network and buffers is to select one of the three or four range conditions, energize one of the three or four decimal lamps in the readout and operate range relays K3, K4, and K5, depending upon the model (5005 or 5010).

Truth tables listing the logic level outputs of the flip-flops along with typical circuits of the lamp and relay buffers are shown in figures 3-2 and 3-3 for the Models 5005 and 5010 respectively.

The buffers operate as follows: if either input 1 or 2 has a logic 1 (+16V) applied, the 2N1305 is reverse biased and the decimal lamp is not energized. If inputs have a logic 0 (+6V) applied, the 2N1305 is forward biased into saturation and thereby energizes the lamp.

For the Model 5005, reset of FF1 and FF2 puts the Digital Voltmeter in the 10V range. The logic diagram (figure 3-2) shows that logic 0 is applied from FF2 to Q12 causing it to energize Decimal Middle Left (DML). The other gates have a logic 1 applied to one of the two inputs and are consequently turned off.

The Digital Voltmeter will remain in the 10V range until the range counter receives a single up-range trigger pulse from the relay logic. This pulse sets FF1 and FF2 causing the logic levels applied to "AND" gate Q13 to be logic 0. This gate turns on Decimal Middle Right (DMR) and energizes relay K4. Pull-in of relay K4 places the range attenuator in the 100V range position.

A second up-range trigger pulse will be generated when operation in the 1000V range is required. This pulse resets FF1. This state of logic conditions causes "AND" gate Q14 to turn on Decimal Right (DR) and pull in relay K5. Logic states cause "AND" gate Q13 to turn off and gate Q12 to remain off. This places the range attenuator in the 1000V position.

When down-ranging from either the 100V or 1000V range is required, a down-range reset pulse, generated in the logic assembly, resets FF1 and FF2 and places the Digital Voltmeter in the basic 10V range. If down-ranging from the 1000V range to the 100V range is required, the range logic will always reset to the basic 10V range and then up-range into the 100V range.

For the Model 5010, reset of FF1 and FF2 puts the Digital Voltmeter in the 1V range. The logic diagram (figure 3-3) shows that logic 0 is applied to both inputs of "AND" gate Q11 causing it to energize the left-most decimal (DL).

The Digital Voltmeter will remain in the 1V range until the range counter receives a single up-range trigger pulse from the relay logic. This pulse sets FF1 causing the logic levels applied to "AND" gate Q12 to be logic 0. This gate turns on Decimal Middle Left (DML) and energizes relay K3. Pull-in of relay K3 places the range attenuator in the 10V range position.

A second up-range trigger pulse will be generated when operation in the 100V range is required. This pulse resets FF1 and sets FF2. This state of logic conditions causes "AND" gate Q13 to turn on Decimal Middle Right (DMR) and pull in relay K4. Logic states cause "AND" gate Q12 to turn off and "AND" gate Q11 to remain off. The pull-in of relay K4 places the range attenuator in the 100V range position.

A third up-range trigger pulse will be generated when operation in the 1000V range is required. This pulse sets FF1. This state of logic conditions causes "AND" gate Q14 to turn on Decimal Right (DR) and pull in relay K5. Logic states cause "AND" gate Q13 to turn off and "AND" gates Q12 and Q11 to remain off. The pull-in of relay K5 places the range attenuator in the 1000V range position.

When down-ranging from either the 10V, 100V, or 1000V range is required, a down-range reset pulse, generated in the logic assembly, resets

FF1 and FF2 and places the Digital Voltmeter in the basic 1V range. If down-ranging from the 1000V or 100V ranges to the 10V range, or from the 1000V range to the 100V range, is required, the range logic will always reset to the basic 1V range and then up-range into the proper range.

DECADE ASSEMBLY

A decade assembly contains the following functional circuits:

1. Relay Logic,

2. A decade section of the precision resistance bridge,

3. Binary-to-decimal decoding matrix,

4. Readout lamp buffers,

5. Relay buffers, and

6. Decade counter.

This assembly converts the count of up- and down-pulses into analog voltage levels. Starting with the most significant decade, these voltage levels are transferred from decade to decade and divided by ten each time before being applied as feedback to one input of the error comparator.

Refer to Schematic 50-114 for circuit reference designations. A decade counter consists of four cascaded binary flip-flops with pulse feedback from the 4th binary to both the 2nd and 3rd binaries. The pulse feedback causes the decade count to fall into correspondence with the basic bit code of the instrument, i.e., 1-2-4-2*.

The truth table of figure 3-15 shows the manner in which the count progresses in the counter and the particular bit of the 1-2-4-2* code associated with each binary. The 0 indicates the absence of a bit and 1, the insertion of a bit. The summation of the corresponding bits results in a total equal to the number of counts stored in the decade.

Physically, the insertion or removal of bits to produce an analog of the count is controlled by relay logic and a string of precision resistors connected as a Wolff-Poggendorf bridge. See figure 3-16.

The binaries associated with each bit of the code are also shown in simplified block diagram form.

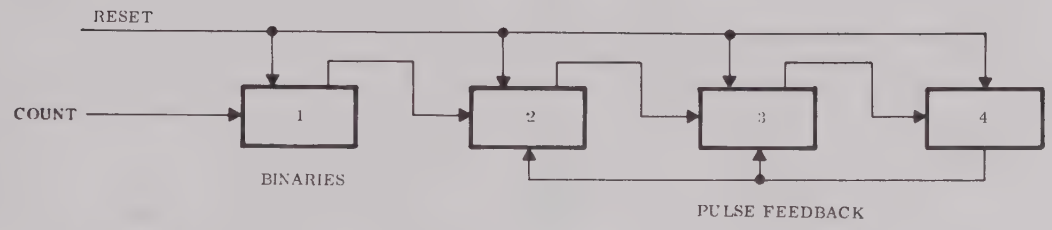
This type of bridge connection always presents a constant resistance to the reference input (terminals A and B). Normally-open and normally-closed relay contact pairs operate simultaneously to insert or remove resistors whose value is proportional to the bit code. The relay contacts are associated with relays that are driven by the buffered logic outputs from the counter binaries. The 11.111K terminating resistor in parallel with the 100K total resistance of the following bridge section results in 10K ohms across points C and D. This connection, called iso-ohmic, allows all decades to have the same value of resistors and to have identical input resistance no matter how many decades of division are used.

Assume a reference input of 10V. As the count progresses from 0 through 9 according to the truth table of figure 3-17, resistors in the upper and lower half of the divider are logically switched in and out by the relays. This produces an increasing voltage of 0 to 9 volts in 1 volt steps across points D and B, and 1 to 10 volts across points C and B. The instrument has four such resistance decades in cascade. The first and least significant decade (right-most digit) is terminated with a 100K resistor to simulate the total resistance of a decade which would normally follow.

Since the accuracy and linearity of the instrument depend almost entirely on the fourth or most significant decade (left-most digit), these resistors are manufactured as a matched set (Model 5010 only). They are carefully assembled, aged and also matched for similar temperature coefficients. This decade is mechanically keyed so that it may not be interchanged with any of the other three.

RELAY LOGIC

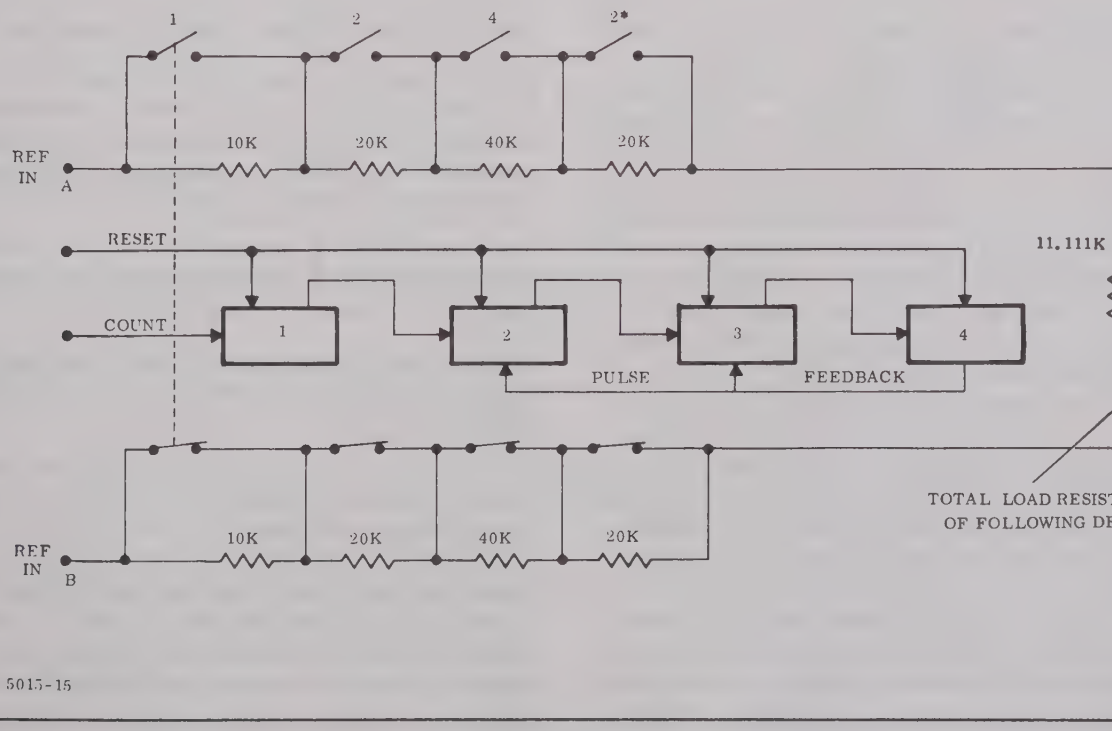
Relay logic is used to control the routing of up- and down-pulses to the count and reset inputs of the decade counter. One relay is associated



COUNT	1	2	4	2*
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	1	1	1
9	1	1	1	1

5015-17

Figure 3-15. Truth Table for Decade Counter



5015-15

Figure 3-16. Wolff-Poggendorf Bridge Section

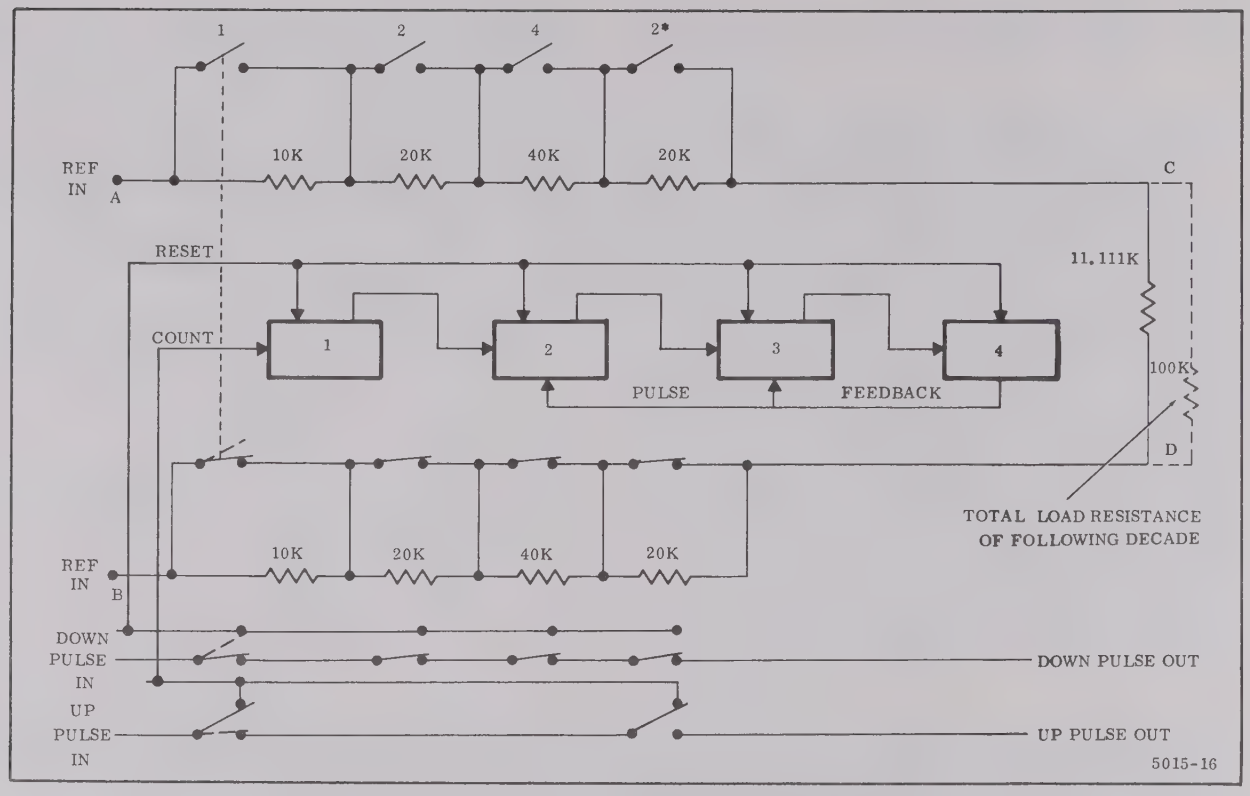


Figure 3-17. Relay Logic Simplified Schematic Diagram

with each of the resistor pairs in the Wolff-Poggendorf bridge - four per decade. Each relay contains the normally open (form A), normally closed (form B) contacts which control the resistance bridge, and two form C contact assemblies for routing the up- and down-pulses.

Relay contacts are shown in their de-energized positions. It can be seen that down-pulses are routed through four form C contacts and up-pulses through only two. Four form C contacts in the down line are required so that no matter which of the four relays are pulled in, the counter can be reset by a following down-pulse. This also disconnects the down-pulses from the down-pulse out line so that this decade must reset before down-pulses can be transferred to the next decade. From the truth table of figure 3-15 it can be seen that the 1 and 2* relays are both pulled in only at the count of 9. At all other counts only one of them is energized. Therefore, only two form C contacts are required to connect the up-pulses to the counter input or transfer the pulses to the next decade. This logic is simple, straightforward and demonstrates the enormous utility of the Printact printed circuit relays.

By following the truth table of figure 3-15 one can determine the logic contact configurations for any of the 0 through 9 counts. A logic 1 indicates that a relay is energized (see position of dotted lines in figure 3-17).

A typical flip-flop circuit used in the decade counter (also in the range counter and polarity flip-flop) is shown in figure 3-18.

The reference designations in this figure are not related to those in Schematic 50-114, Decade Assembly.

CR1, R3, C1, and CR2, R4, C2 are the input steering networks to the flip-flop. The positive-going trigger is steered so as to turn an on transistor off. Diodes CR3 and CR4 serve to isolate external loads from the biasing networks of the flip-flop. R9 and R10 provide a ground return for an off transistor. R11 is a base current limiting resistor for a relay buffer. R12 is a trigger current limiting resistor.

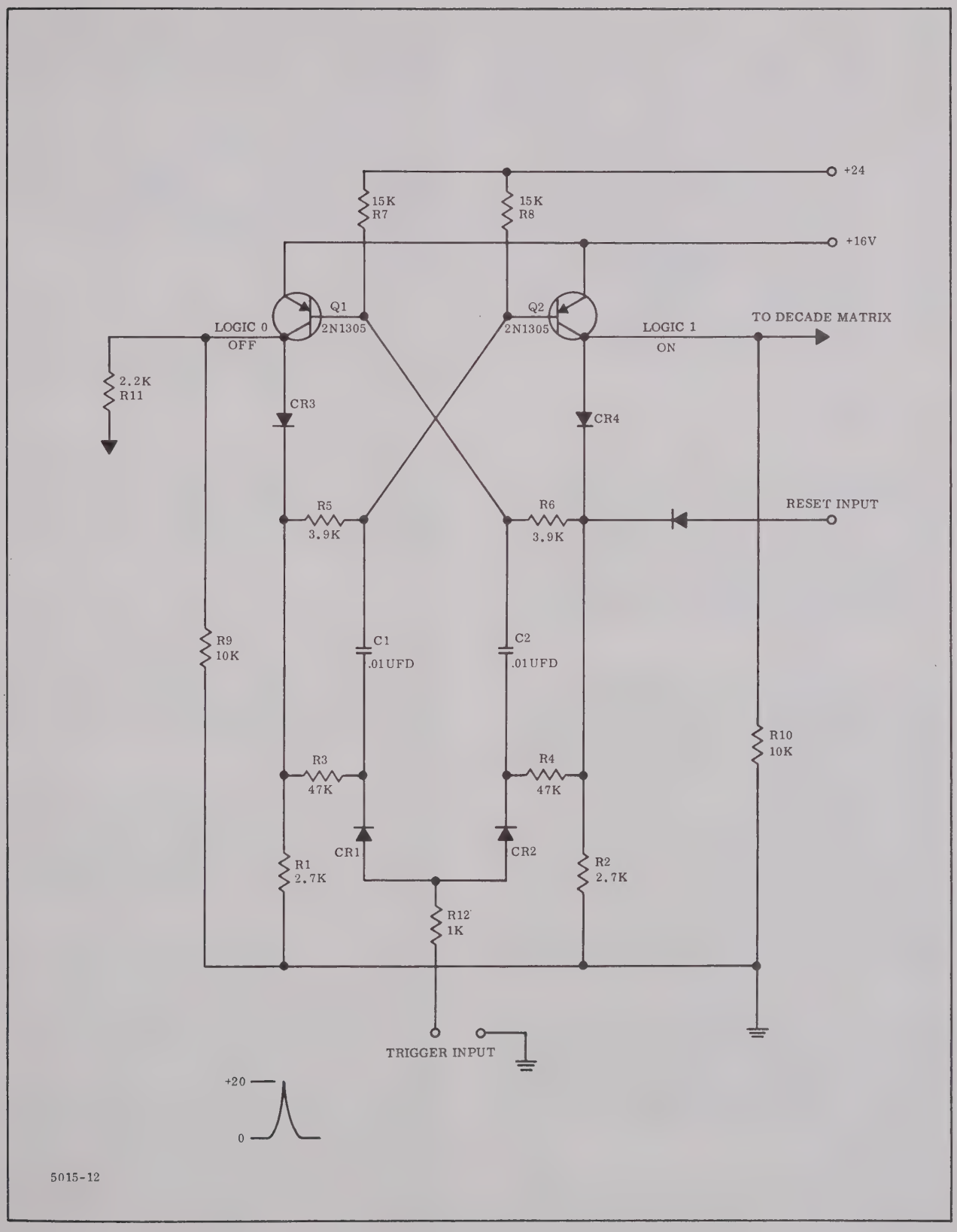


Figure 3-18. Typical Flip-Flop Circuit Simplified Schematic Diagram

Refer to Schematic 50-114 which shows the flip-flop circuits CR3, CR7, CR11, and CR14 are reset diodes connected to the down-pulse line. Diodes CR4 and CR8 are pulse (or level shift) feedback diodes used to set the 2nd and 3rd flip-flops whenever the 4th is set. See truth table of figure 3-15. Diodes CR32, CR33, CR34, and CR35 are part of the up-ranging logic of the DVM. The input to these diodes, called the range logic set, is used to set the 4th decade to a numerical 1 configuration when the up-range transfer from 9.999V to 10.00V is being made. This causes the up-range transfer to occur with only 1 up and 4 down-pulses.

DECODE MATRIX

Lamps in the Digital Voltmeter Readout must be energized to illuminate a digit corresponding to the magnitude of any of the 0 through 9 discrete voltage steps of the bridge. A diode matrix of 13 diodes is used to convert the 4-bit binary numbers to 10-line decimal outputs. A simplified block diagram of the decoding scheme is shown in figure 3-19.

To minimize the number of decoding diodes used, "even" and "odd" gates are used to inhibit all odd numbered lamps when an even numbered lamp is to be energized and vice versa. A logic 1 applied to any buffer gate will turn it off. Thus, to turn on the 0 lamp, logic 0 is first required at the input to the "even" gate from the first flip-flop to enable all even numbers. The even number 0 is selected by connecting diodes from the 0 buffer gate to the logic 0 output of flip-flops 2, 3, and 4 respectively. These diodes are also connected to the input of lamp buffer gate 1 but it is inhibited because the "odd" gate is turned off.

A single count into flip-flop 1 will cause its logic outputs to reverse. This turns off the "even" gate and turns on the "odd" gate. Since logic 0's are already connected to lamp buffer 1, it will turn on. See figure 3-20 for a typical lamp buffer circuit.

A second count resets flip-flop 1 and sets flip-flop 2 causing their logic outputs to reverse. This turns off the "odd" gate and turns on the "even" gate. It also applies logic 0 to lamp buffer 2 and since logic 0 is already applied to lamp buffer 2 from flip-flop 3, it will turn on.

A third count sets flip-flop 1 causing its logic to reverse. This turns off the "even" gate and turns on the "odd" gate. Since logic 0 is already applied to lamp buffer 3 from the connections of flip-flops 2 and 3 to lamp buffer 2, lamp buffer 3 will turn on.

A fourth count resets flip-flops 1 and 2 and sets flip-flop 3 causing their outputs to reverse. This turns off the "odd" gate and turns on the "even" gate and applies logic 0 from flip-flops 2 and 3 to lamp buffer 4, turning it on.

A fifth count sets flip-flop 1 causing its logic to reverse. This turns off the "even" gate and turns on the "odd" gate. Since logic 0 is already applied to lamp buffer 5 from the connections of flip-flops 2 and 3 to lamp buffer 4, lamp buffer 5 will turn on.

A sixth count resets flip-flop 1 and sets flip-flops 2 and 3 causing their logic outputs to reverse. This turns off the "odd" gate and turns on the "even" gate. It also applies logic 0 to lamp buffer six from flip-flops 2 and 3 and since logic 0 is already applied to lamp buffer 6 from flip-flop 4, it will turn on.

A seventh count sets flip-flop 1 causing its logic to reverse. This turns off the "even" gate and turns on the "odd" gate and since logic 0's are already applied to lamp buffer 7 from the connections of flip-flops 2, 3, and 4 to lamp buffer 6, it will turn on.

An eighth count resets flip-flop 1 and sets flip-flop 4 causing their logic outputs to reverse. This turns off the "odd" gate and turns on the "even" gate; it also applies logic 0 to lamp buffer 8 from flip-flop 4, causing it to turn on.

A ninth count sets flip-flop 1 causing its logic to reverse. This turns off the "even" gate and turns on the "odd" gate. Since logic 0 is already applied to lamp buffer 9 from the connections of flip-flop 4 to lamp buffer 8, lamp buffer 9 will turn on.

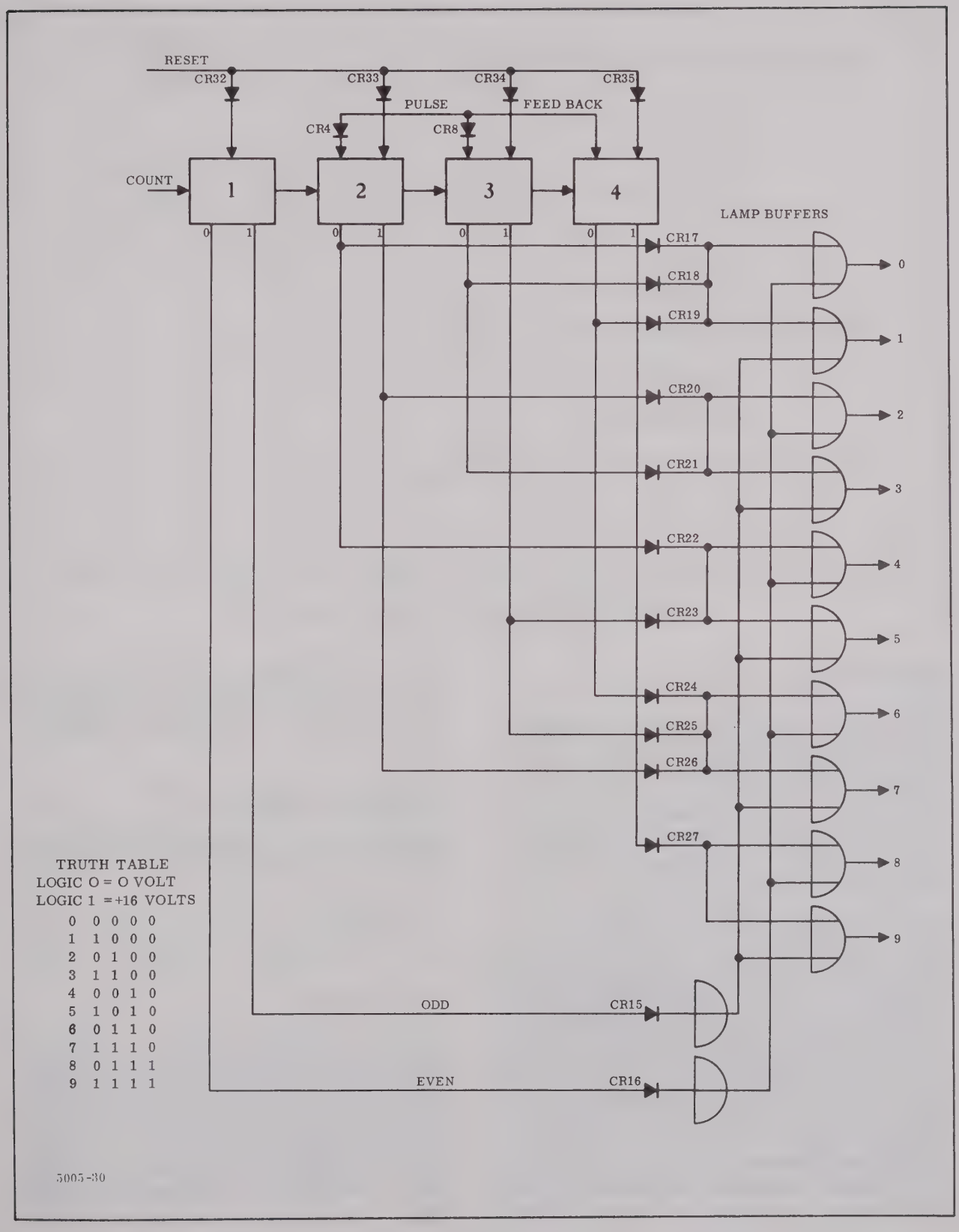


Figure 3-19. Simplified Block Diagram of Decoding Scheme

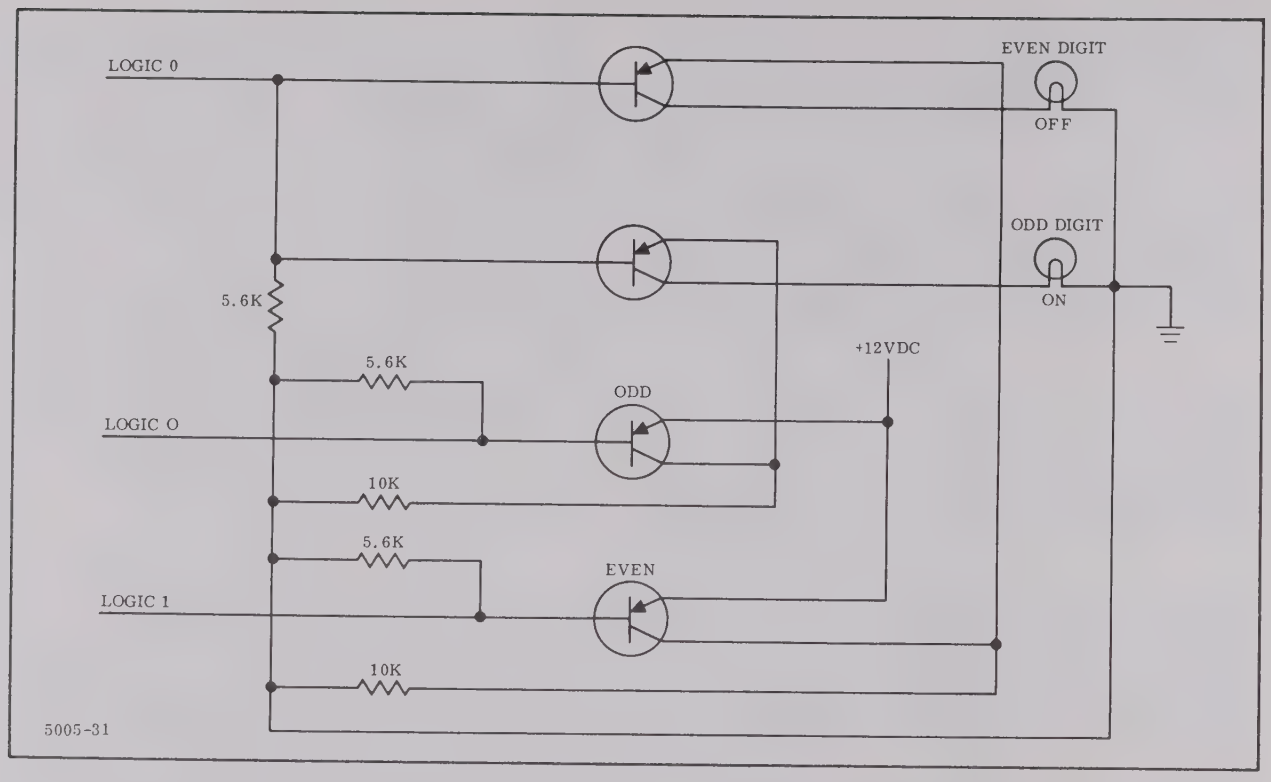


Figure 3-20. Typical Lamp Buffer Circuit

RELAY BUFFER

A relay buffer is used to energize the Printact logic relays in order to prevent excessive loading of the flip-flop. The relay coils require 40 ma at 12 VDC. The typical circuit shown in figure 3-21 operates between the +24 and +12V power supply busses. The input signal is a +16V level shift obtained from an on collector of a counter flip-flop.

With 0-volts input the base emitter junction is backed biased with +12V and the relay K1 is de-energized. A +16V input saturates Q1 and energizes relay K1, general purpose diode CR1 and Zener diode CR2 comprise a "quick dropout" circuit for the relay buffer. CR1 blocks the +24 volt supply to prevent relay K1 from being shunted by forward conduction through Zener diode CR2. When a relay is de-energized, the inductive "kick" of the relay coil is permitted to rise to the breakdown level of the Zener diode, 8.2V, before conduction and clipping occurs. If CR2 were removed and CR1 used above, the dropout time would increase by a factor of up to 3 to 1. The Zener diode may be shared by the remaining buffers in the decade as shown in Schematic 50-114.

POWER SUPPLY ASSEMBLY

The power supply assembly provides three regulated output voltages:

1. +12 VDC
2. +16 VDC and
3. +24 VDC.

The +24 VDC is utilized in the pulse amplifier of the amplifier assembly, as a biasing supply in all flip-flops, and as a collector supply for the chopper drive multivibrator and Delay No. 1 in the logic assembly. The +16 VDC is used as a collector supply for all flip-flops. The +12 VDC is used to power chopper coil buffers, Delay No. 2 (see block diagram) and all lamp

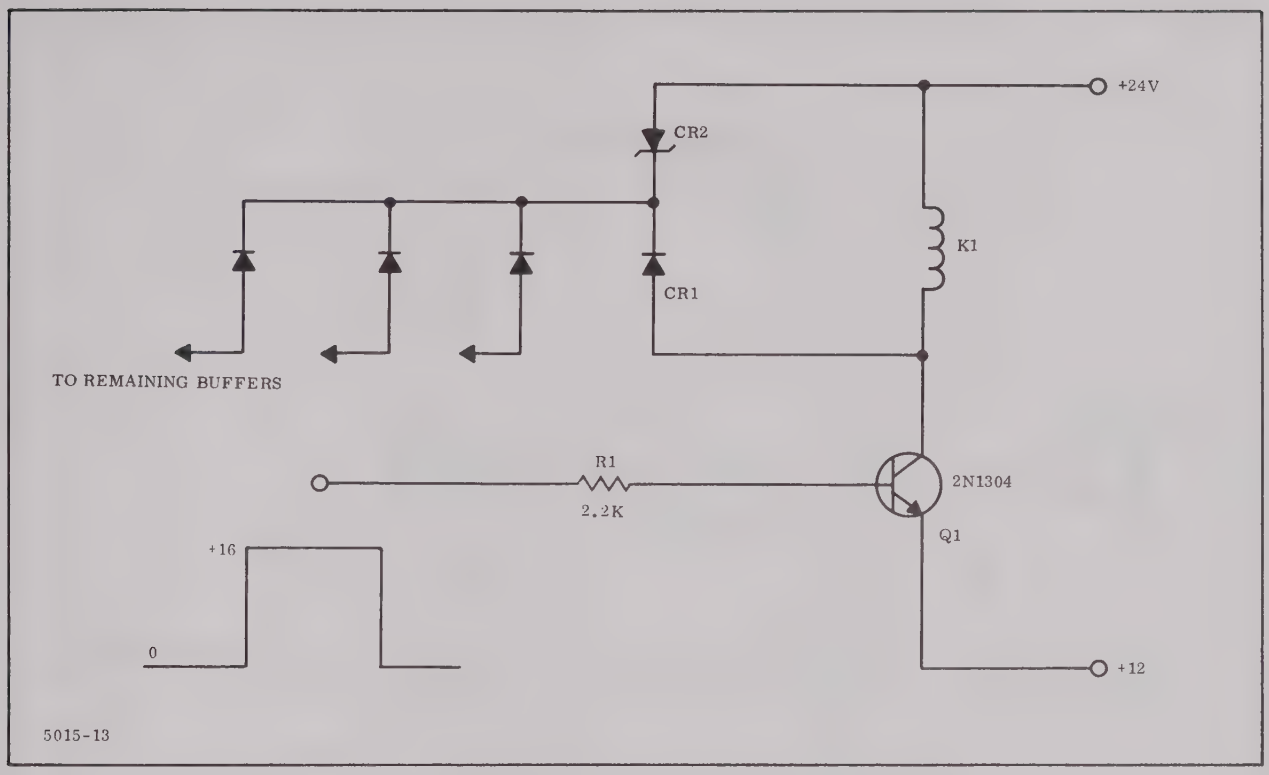


Figure 3-21. Relay Buffer Simplified Schematic Diagram

and range relay buffers. Relay buffers in the decades operate between the voltage levels of +12 VDC and +24 VDC.

Two 19 VAC windings supply power to the assembly. The assembly consists basically of two 12V regulated supplies whose outputs are grounded and connected in such a way as to obtain +12 VDC and +24 VDC. The +16 VDC is obtained by means of an emitter follower regulator connected between the +12 and +24 volt outputs. A simplified block diagram of the circuitry is shown in figure 3-22.

The assembly consists basically of two full-wave bridge rectifiers followed by a filter capacitor, two series regulators and one emitter follower regulator. A single-reference supply is shared as a reference source by both series regulators. This is made possible by using the output of one regulator as a reference for the other.

For purposes of explanation, assume that the power supply is grounded as shown in figure 3-23 to provide plus and minus 12 VDC with respect to ground. Zener diode CR9 provides the basic regulating reference for the dual regulated supplies. Its magnitude will lie between 10-12V. Assume that it is exactly -12V. An emitter follower consisting of Q3 and R14 prevents loading by resistor R2. Assume its output is -12 VDC. This -12V reference is summed with the regulated output of the +12V supply by means of resistors R2 and R1. These voltages produce currents of opposite polarity in the summing resistors. Any difference between the two currents flows into (or out of) the input to DC amplifier A. As this error current is amplified and applied to the base of Q1, it causes Q1 to adjust the regulated output voltage in such a direction as to make the error current zero. By making R1 equal to R2, the regulated output voltage is forced to become equal in magnitude but opposite in polarity, i.e., if the reference input to R2 is -12 VDC, the regulated output is +12 VDC.

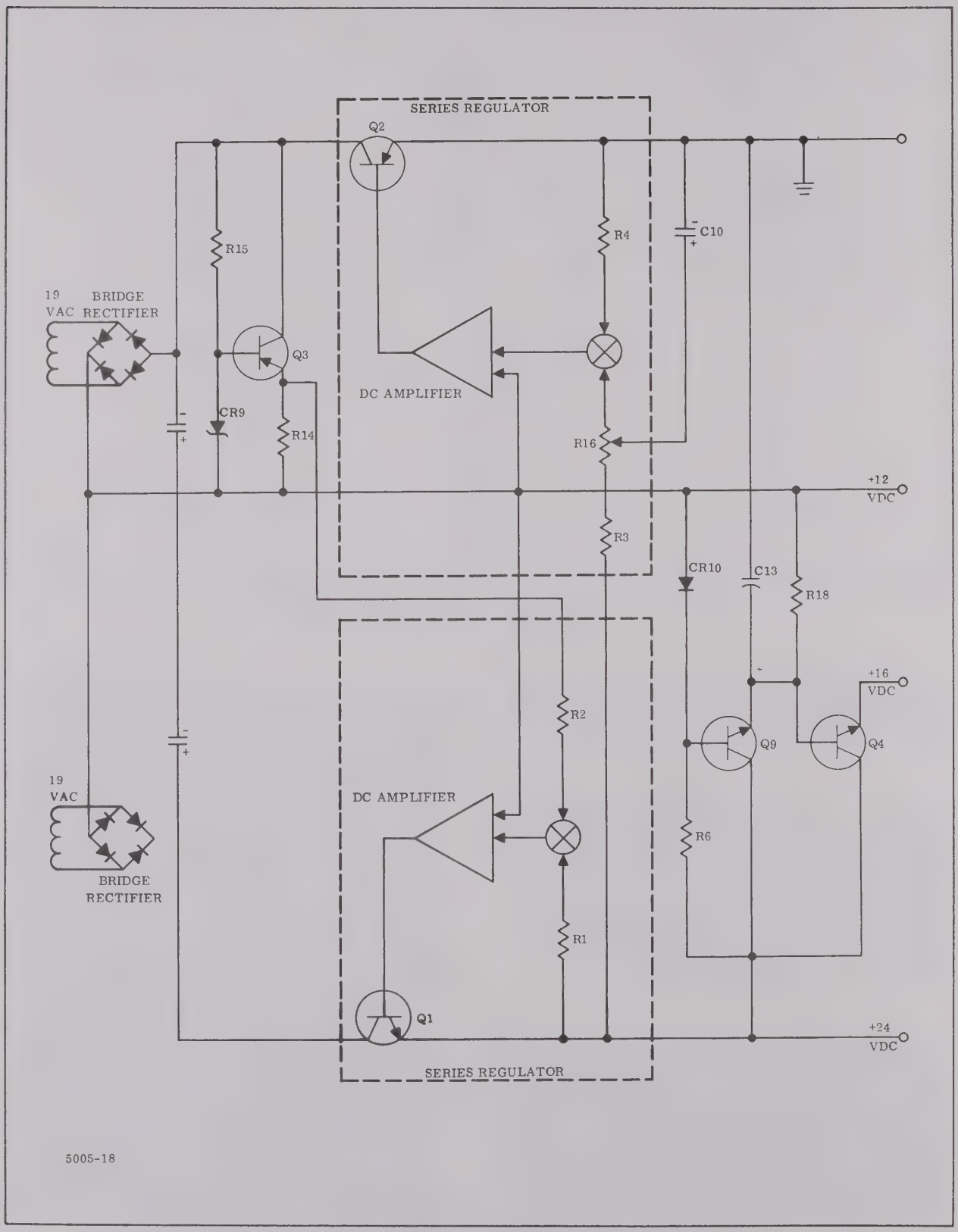


Figure 3-22. Power Supply Simplified Schematic Diagram

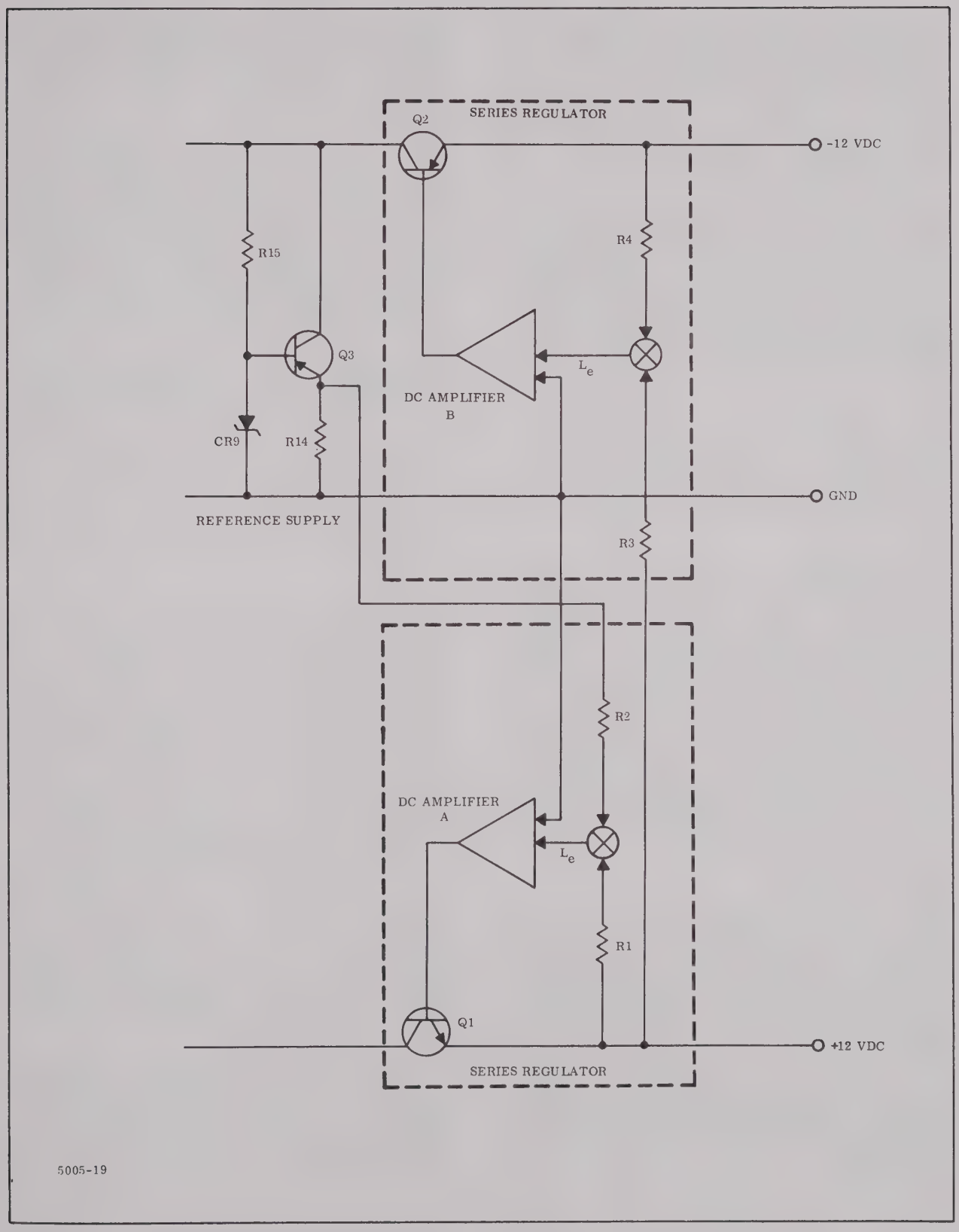


Figure 3-23. Power Supply Simplified Schematic Diagram (Modified)

If we assume that the +12 VDC output is now the reference input to DC amplifier B, similar reasoning shows that the output at the emitter of Q2 must become -12 VDC. If the ground for the dual power supplies is moved to the emitter of Q2, the outputs of the two regulators are placed in series to produce 0, +12 VDC, and +24 VDC respectively.

The +16 VDC output is obtained by means of a Darlington-connected emitter follower operating between the +24V and +12V power supply levels. The nominal breakdown voltage of Zener diode CR10 is 4 VDC. Therefore, the output at the emitter of Q4 becomes 16 VDC with respect to ground.

The actual regulated output voltages are affected by the tolerance of Zener diode CR9 and variations in the base-emitter drops of Q3, Q7, and Q8. Therefore, potentiometers R16 and R17 are used to adjust the regulated outputs to +12V and +24V.

The summing junction shown in figures 3-22 and 3-23 are at the bases of Q7 and Q8 (see Schematic 50-7). Capacitors C9 and C10 bypass resistors R1 and R4 to provide a large amount of negative feedback at the ripple frequency to attenuate ripple voltage. Transistors Q1 and Q2 are mounted on heat sinks which are fastened to the inner guard box. Otherwise, all power supply components are mounted on a single plug-in board. Capacitors C11 and C12 are used to attenuate voltage spikes caused by the switching action of the bridge rectifiers.

PRINT OPERATION

The standard Model 5005 and 5010 DVMs do not include a print-out function; however, many users of the instruments desire this capability. The following paragraphs provide information on print operation for instruments containing this function.

Turn voltmeter function switch to ON and determine that the DVM is functioning properly by exercising it with suitable inputs over the range of 0 $\pm$10 VDC.

Place function switch in CONTINUOUS position. This puts the voltmeter in a standby condition until a command to read voltage and print is received. This command may be called the "Read Command."

The "Read Command" is given by Form C contacts connected to pins 76, 79, and 80 of print connector J9 as shown on Schematic 50-77. These contacts are supplied by the customer. The normally closed contacts connected to pin 79 must be opened and closed to provide a "Read Command." The subsequent closure initiates the "Read Command."

This contact closure triggers the print delay circuit causing relays K1, K3, and K4 to pull in. The opening of relay K4 contacts releases the voltmeter from the standby condition. The closing of relay K1 contacts completes a circuit for up- and down-pulses to be applied to the print delay circuit, thus keeping relays K1, K3, and K4 held in as long as the voltmeter is balancing.

When relay K3 drops out, approximately 100 milliseconds after the last up or down pulse occurs, both the amplifier inhibit multi and the print command relay multi are triggered. The normally open contacts of relay K2 close for 15 milliseconds after relay K3 drops out to provide a contact closure "Print Command" available at pin 49 and pin 37 of print connector J9. The dropout of relay K4, simultaneously with relay K3, puts the voltmeter back in the standby condition while the external print cycle proceeds to record the binary coded decimal voltage levels which are available at print connector J9.

The operation of the amplifier inhibit multi, and relay K5 are redundant in the CONTINUOUS print mode. In the AUTO mode, this circuit places the voltmeter in STANDBY for 250 milliseconds after relay K4 drops out.

In the AUTO mode of print, the voltmeter is continuously enabled to read voltage and voltage changes. When voltage is first applied to the voltmeter, up and down pulses which occur while the instrument balances are applied to the

print delay circuit through contacts of the function switch. Relays K1, K3, and K4 pull in; however, the contact closure of relay K1 is redundant, relay K4 contacts have been disabled by the function switch, and relay K3 contacts close to ground. One hundred milliseconds after the last up or down pulse (signifying balance has occurred) relays K1, K3, and K4 drop out. The dropout of relay K3 triggers amplifier inhibit multi and energizes relay K5 for 250 milliseconds. The contacts of relay K5 place the voltmeter in STANDBY. The print command multi is triggered simultaneously with the amplifier inhibit multi. The normally open contacts of relay K2 close for 15 milliseconds to provide a contact closure "Print Command." After 250 milliseconds, relay K5 drops out, removing the voltmeter from the STANDBY condition, and thus puts the instrument in readiness to read and print the next change in voltage.

The contacts of relay K2 can be arranged (on special request) to provide normally closed contacts, rather than normally open, available at pins 49, and 37 of J9. It is recommended that the trailing edge of the 15 milliseconds closure period, i.e., when the contacts of relay K2 open again, be used to initiate "Print Command" to external print equipment. This times the "Print Command" to occur 15 milliseconds after the voltmeter has been placed in the STANDBY condition by relay K5.

CHAPTER IV

CALIBRATION

When a Model 5005 or 5010 Digital Voltmeter is not making readings within specifications, it is time for calibration, repair or both. In the calibration information provided in this chapter, it is assumed that the instrument is in good working order and only requires calibration. If any components are defective, it may be difficult, if not impossible, to calibrate the instrument properly.

The calibration procedure is divided into five distinct areas: gain adjustment, basic accuracy adjustment, range adjustment, final gain check, and power supply adjustment. See figure 4-1 to determine the locations of all adjustment points and see figures 4-2 and 4-3 for test equipment connections.

NOTE

Earlier models of the 5005 and 5010 Digital Voltmeter did not include provisions for adjustment of the power supply module. Users of instruments not having adjustment potentiometers R16 and R17 on the Power Supply Assembly (figure 4-1), should disregard power supply adjustment instructions.

EQUIPMENT REQUIRED

1. A bank of nine standard cells: NLS E.M.F. Standard No. 3006.

2. A DC High Voltage Supply and Calibrator, NLS Model 3021.

3. A Ratio Test Fixture, NLS Model 3022.

4. A Triplett Model 630-NA Voltmeter or equivalent.

5. A Dekavider, Model DV-411, Electro Scientific Industries.

6. Two Extension Boards, NLS P/N 1009-22.

7. A DVM Signal Input Cable, No. 5123.

8. An Interconnecting Cable, Ratio Test Fixture to DC High Voltage Supply and Calibrator, No. 3022-008.

9. An Interconnecting Cable, Ratio Test Fixture to DV-411 Dekavider, No. 3022-033.

INITIAL PREPARATION

1. Plug DVM power cord in to 115-volt line. Turn power switch to STANDBY. Allow meter to warm up for one-half hour.

2. Interconnect the Ratio Test Fixture, DC High Voltage Supply and Calibrator and DV-411 Dekavider using Cables 3022-008 and 3022-033.

3. Turn DC High Voltage Supply power switch to STANDBY and allow the unit to warm up for one-half hour.

4. Turn Ratio switch to OFF and Range switch to 10 on the Ratio Test Fixture. Connect DVM to Ratio Test Fixture as shown in figure 4-2.

GAIN ADJUSTMENT

1. Turn DVM power switch to "ON".

2. Turn DC High Voltage Supply and Calibrator power switch to "ON".

3. Set all Dekavider dials to zero. All DVM readout windows should read zero.

4. Using the least significant dial of the Dekavider, increase the signal voltage to the voltmeter and then slowly decrease it. The DVM should count down one digit at a time. If not, error amplifier gain is too low.

5. Remove the top cover and top of guard box. Some instruments will have access holes for potentiometer adjustments in the guard box top cover. If not, always replace guard box

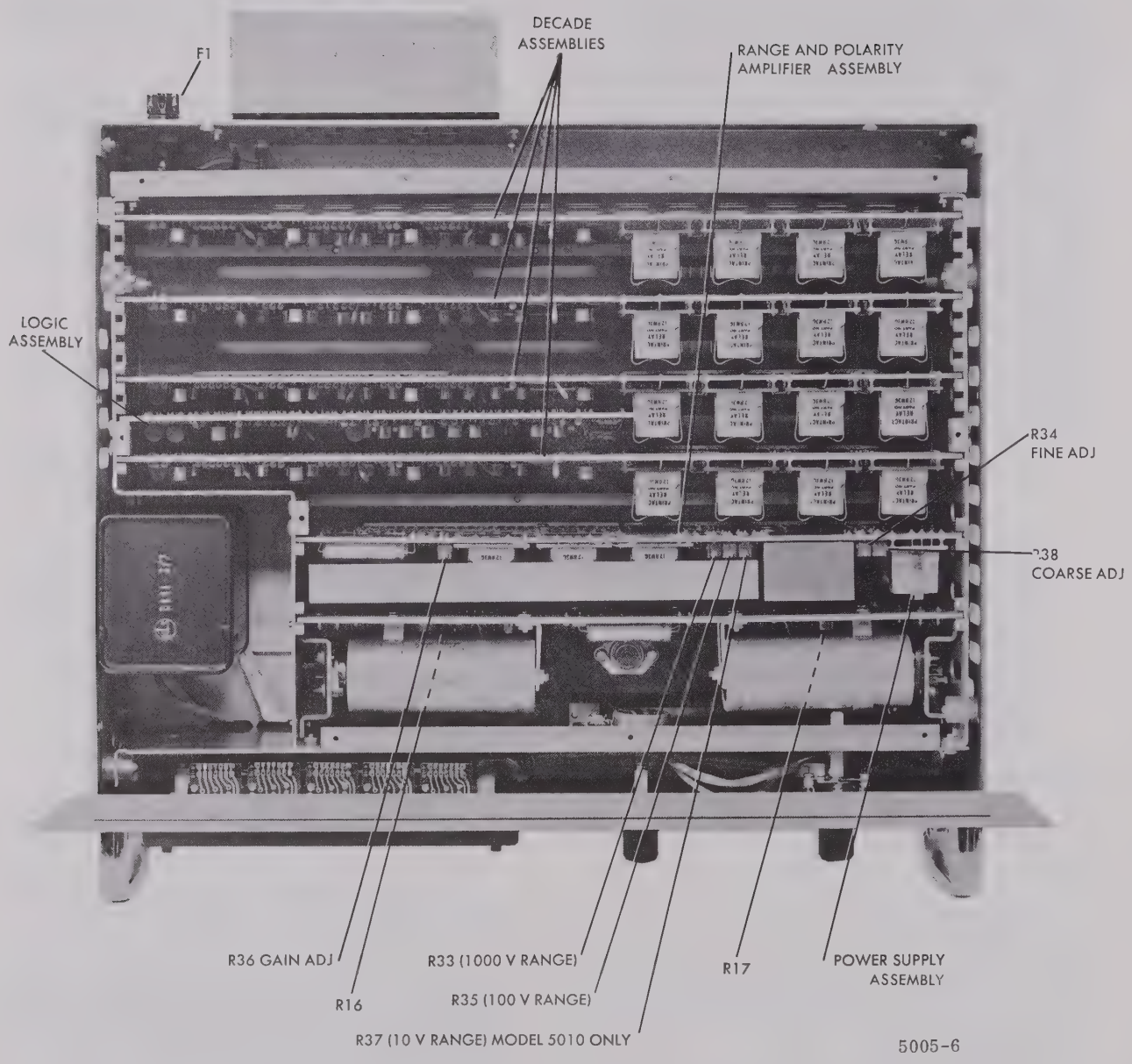


Figure 4-1. Location of Adjustment Points

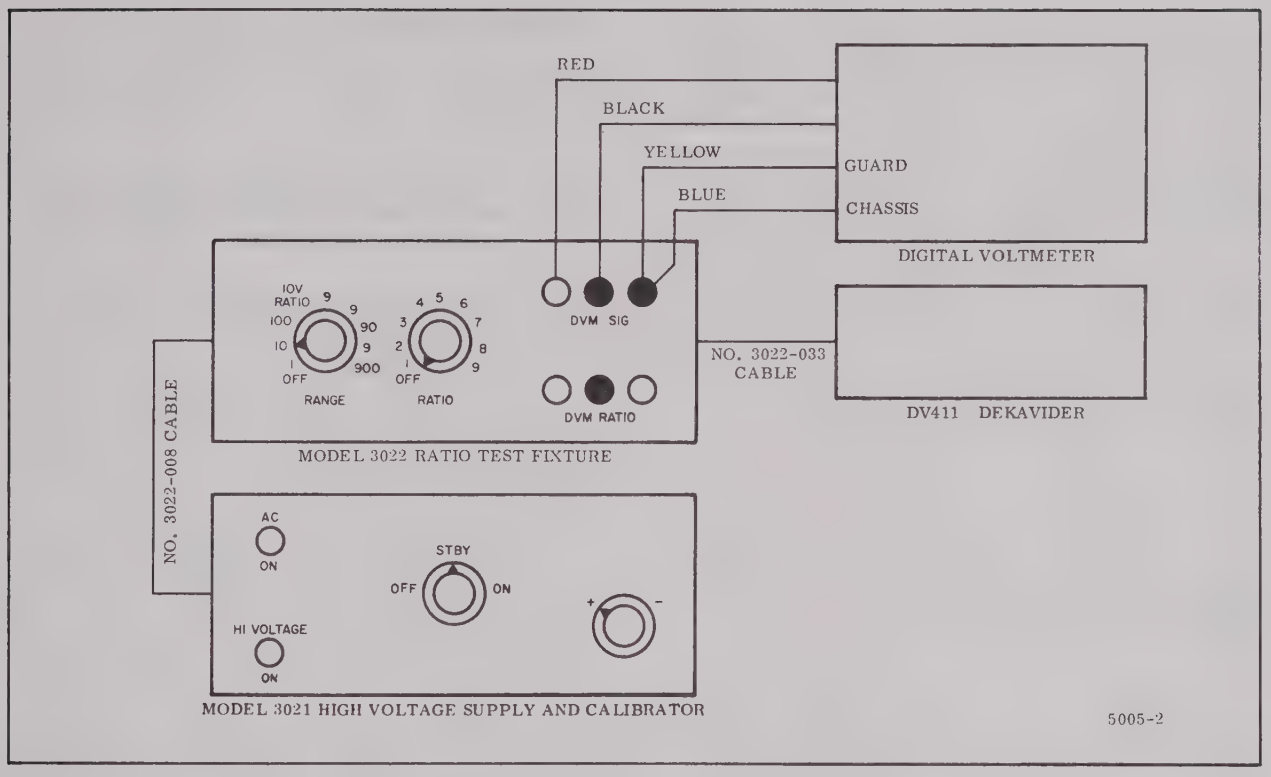


Figure 4-2. Cable Connections

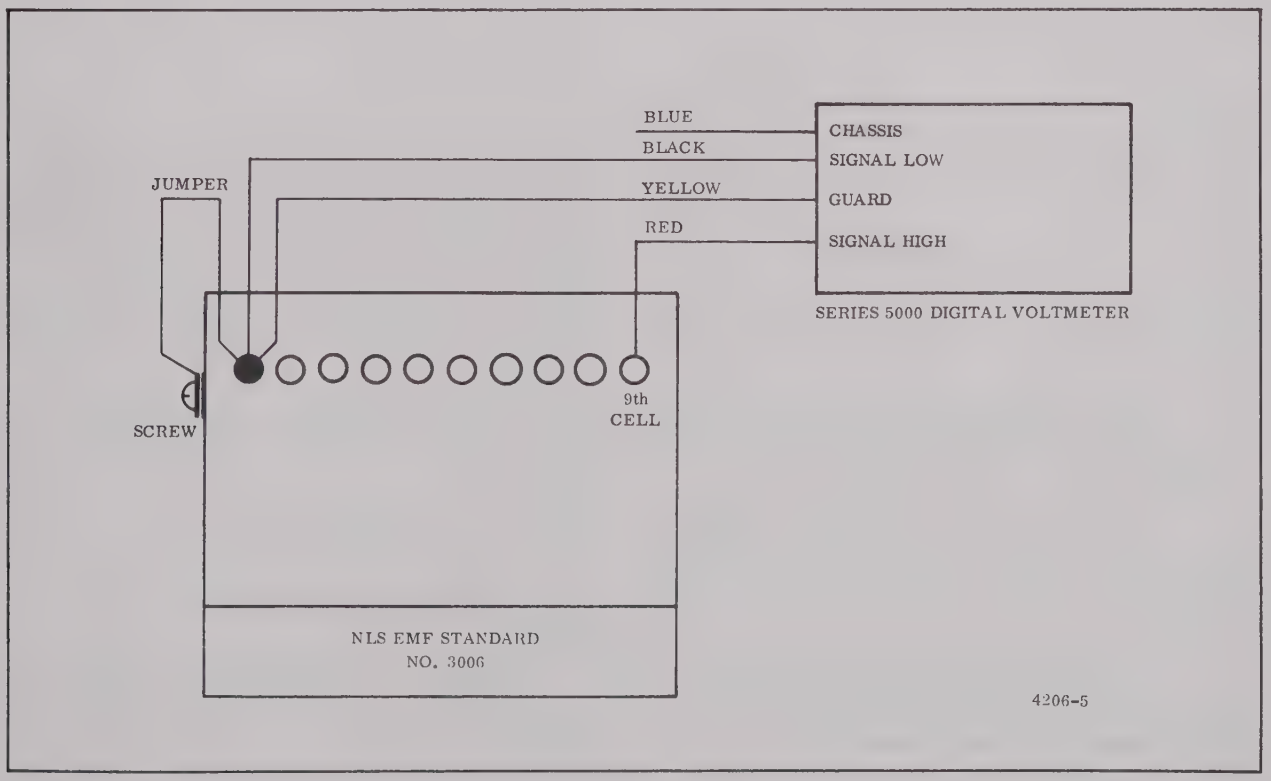


Figure 4-3. Cable Connections

cover (use only one screw) temporarily after making the adjustments. Increase gain by turning gain potentiometer R-36 on the Amplifier Assembly in a clockwise direction. Slowly decrease signal input to the DVM. Gain is correct when the meter barely counts down 1 digit at a time. If calibrating the 5005, the instrument now has a 1 millivolt sensitivity; if calibrating the 5010, the instrument now has a 100 microvolt sensitivity. If gain is too high - least significant digit unstable or rolling - R36 should be turned counterclockwise to reduce gain. Keep DVM front panel sensitivity control fully clockwise during this adjustment.

BASIC ACCURACY CALIBRATION

1. Disconnect DVM signal input leads from Ratio Test Fixture, and connect to standard cell bank as shown in figure 4-3.

2. The DVM should display the carded value of the 9 standard cells, e.g. 9.165 V; if not, adjust coarse and fine adjustment potentiometers R-38 and R-34 until it does.

For the 5005, the calibration is now set in the basic range of 10 VDC.

For the 5010, since the range potentiometers in the 10 megohm range divider have not been set or ratioed, this adjustment is preliminary and will get the accuracy to within $\pm$10 digits of the actual value.

RANGE CALIBRATION (MODEL 5005)

Re-connect the DVM to the Ratio Test Fixture as before.

1. Set RANGE switch on the Ratio Test Fixture to 9. Observe the reading on the 9.999V range and record. Say it was 9.136.

2. Next, set RANGE switch to 90. Observe the reading. Meter should read 91.36. If not, adjust R-35 until it does.

3. Next, set RANGE switch to 900. Observe the reading. Meter should read 913.6. If not, adjust R-33 until it does.

RANGE CALIBRATION (MODEL 5010)

Re-connect the DVM to the Ratio Test Fixture as before.

1. Set RANGE switch on the Ratio Test Fixture to .9. Observe the reading on the .9999V range and Record. Say it was .9136.

2. Next, set RANGE switch to 9. Observe the reading. Meter should read 9.136. If not, adjust R-37 until it does.

3. Next, set RANGE switch to 90. Observe the reading. Meter should read 91.36. If not, adjust R-35 until it does.

4. Next, set RANGE switch to 900. Observe the reading. Meter should read 913.6. If not, adjust R-33 until it does.

FINAL ACCURACY CALIBRATION (5010 ONLY)

Re-connect the DVM to the standard cell bank as before. The DVM should read the carded value of the 9 standard cells. If not, re-adjust coarse and fine reference adjust potentiometers, R-38 and R-34, until it does.

FINAL GAIN CHECK

Re-connect the DVM to Ratio Test Fixture as before (figure 4-2). Set all Dekavider dials to zero. Apply input signals to the DVM using the least significant dial on the Dekavider. Check gain as before, Step 4 under GAIN ADJUSTMENT. Adjust gain to make meter count down one digit at a time. Use only as much gain as needed to barely get one-digit steps as meter counts down.

Gain, accuracy and range calibration is complete. Remove DVM input leads from Ratio Test Fixture.

POWER SUPPLY ADJUSTMENT

1. Remove Power Supply Assembly from DVM.

2. Insert extension boards into power supply connectors J11 and J12 on Main Board Assembly.

3. Mount Power Supply Assembly on top of extension boards by inserting power supply board pins into extension boards. Use care to ensure proper pin alignment.

4. Connect a Triplett Model 630-NA Voltmeter or equivalent between the +12V and +24V outputs, pin 9 and pin 11 of P1.

5. Set meter range switch to 60V and scale switch to V/2.

6. Adjust R17 until meter reads +12 VDC.

7. Connect meter between ground and the +12V output at pin P2-9 and P1-9.

8. Adjust R16 until meter reads +12 VDC.

9. Remove Power Supply Assembly from extension boards.

10. Remove extension boards from Main Board Assembly.

11. Replace Power Supply Assembly.

CHAPTER V

MAINTENANCE

If the Digital Voltmeter is not working properly, or if it cannot be calibrated according to instructions, service will be required.

EXTENSION BOARDS

During maintenance procedures, two 22-pin extension boards will be required to raise each plug-in module (only one board is required for the logic assembly) so that pin contacts on the bottom of the circuit board become accessible for the measurement of voltages and the observation of wave forms. These boards, NLS part number 1009-22, may be ordered from any NLS Representative or from the NLS Main Office in Del Mar, California.

GENERAL PROCEDURE

Before seeking out specific defective components, it is best to establish that the several power supplies are working. Specifically, voltage checks should be made at the voltage output points of the power supplies as indicated on the schematic drawings. A simple 20,000 ohm-per-volt d'Arsonval type meter may be used for these measurements. The voltage measurements should indicate correct values $\pm$15% when read on a voltmeter with a rated accuracy of $\pm$13%. The outputs of the regulated power supplies cannot be accurately read by this method, but in practice the accuracy of their outputs need not be known; if a regulated power supply fails, it is most likely that the voltage error will be gross (or there will be no output at all) and therefore detectable with simple measuring instruments.

If a measured voltage appears to be at an improper value, the associated power supply components should be checked; if none of these are found to be defective, it will be necessary to proceed along the defective power path, checking wiring, connectors, printed circuitry, and finally components on the boards. An obvious way to make a speedy check is to replace suspected defective boards with known good ones. Since the decade boards are all interchangeable (except as noted on page 1-1), a malfunction affecting one decade of the readout can be made to affect other decades. For this reason, it is suggested that a trial and error approach be used and the decade boards be interchanged. If the malfunction then manifests itself in a previously unaffected decade, the defective board can be readily isolated. From this point on, a test of components will locate the precise area of failure.

If is suggested that the individual schematics be studied so as to better know what outputs may be expected at each function.

TROUBLESHOOTING

Table 5-1 lists specific types of malfunction. Note that any of dozens of components could fail and yet the symptom would be the same for all, there is no one component which can readily be singled out as a consistent offender. For this reason, the most useful approach to trouble-shooting is to provide a list of possible types of failure and identify the plug-in board or circuit area most likely to contain the defective component.

PRINTACT RELAY REPLACEMENT

The Printact relays (P/N 5005-006), located on the four decade assemblies (4 on each board) and on the amplifier assembly (3 on the Model 5005 and 4 on the Model 5010) may be removed and replaced by performing the following steps. See figures 5-1 through 5-3.

1. Remove the board assembly from the instrument.

2. Grasp the relay housing between thumb and forefinger on the two sides not touching the metal retaining-clip.

3. Partially insert a thin-bladed screwdriver between the metal clip and a side of the relay housing.

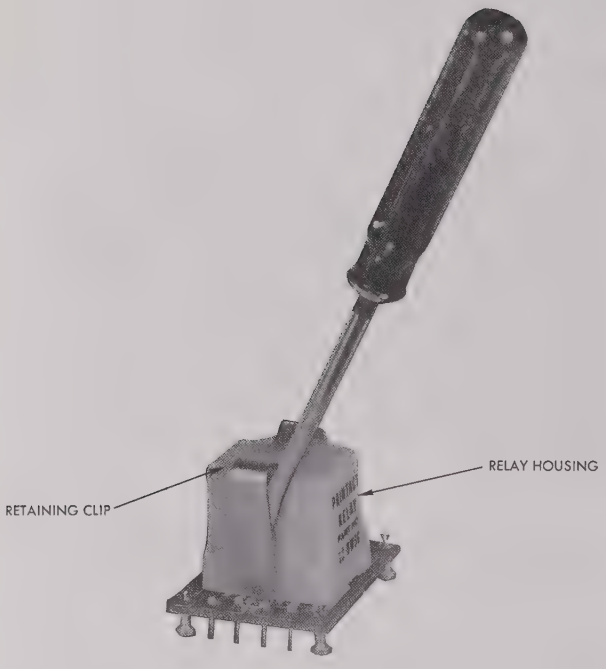


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Figure 5-1. Relay Removal Initial Step

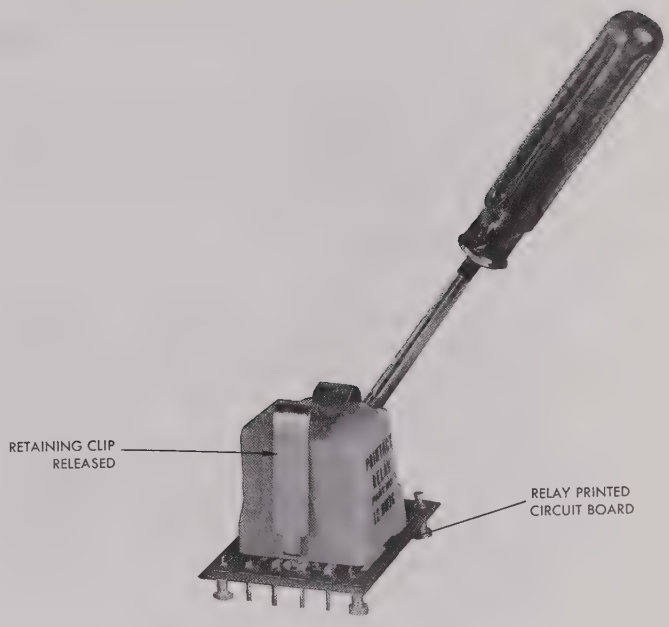
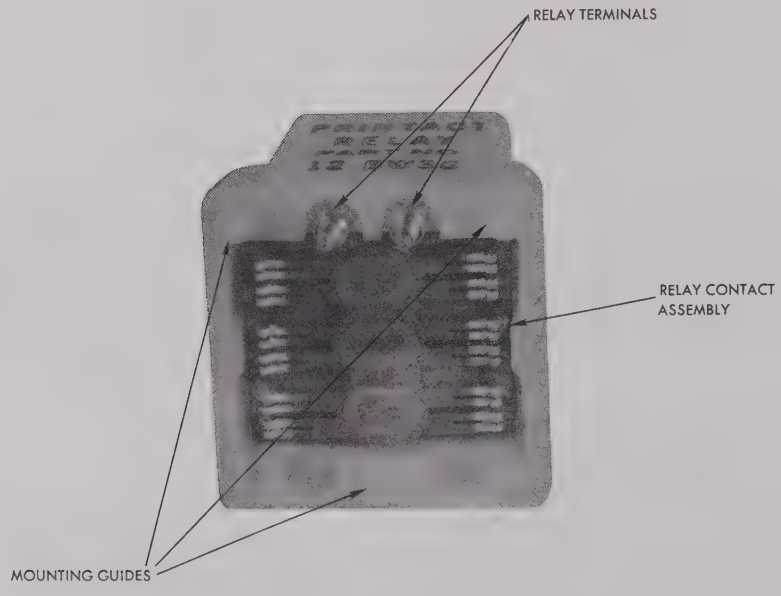


Figure 5-2. Relay Removal with One Side of Clip Released



5005-22

Figure 5-3. Relay Terminals and Mounting Guides

Table 5-1. Troubleshooting

SYMPTOM	PROBABLE DEFECTIVE BOARD
Readout locks on 9 in a given decade	Decade Assembly (Relays)
Polarity Lights are out or are incorrect	Logic Assembly, Readout
Decimal lights are out or are incorrect	Logic Assembly, Readout
Multiple lights appear in one or more decades	Decade Assembly
A particular digit fails to illuminate	Readout Bulb
Readout is locked at 9999, or is unstable and seeks 9999 regardless of input voltage	Amplifier Assembly Logic Assembly
Readout displays 9999 in one polarity, but not in other, regardless of input voltage	Logic Assembly Amplifier Assembly
Instrument skips digits, or has "holes" in decades. Transfers and linearity are poor	Decade Assembly (Bridge Resistors)
Readout shows only certain numbers in decades	Decade Assembly (Decode Matrix)
Instrument reads correctly in one polarity, but loses digits in the other	Amplifier Assembly (Reference, Polarity Relays, Circuit Board Leakage)
Readout illumination is dim	Power Supply Assembly
Readout displays erroneous values which are somewhat proportional to the input voltage	Amplifier Assembly (Range Divider)
Readout Display is consistently higher than the input voltage	Amplifier Assembly (Reference)
Readout "sticks" on particular numbers	Decade Assembly (Relays)

4. Gently twist the screwdriver to raise the clip away from the base of the housing. The bent tip of the clip will spring out of the hole in the relay printed circuit board.

5. Perform steps 3 and 4 for the other side of the relay.

6. Gently pull the relay away from its printed circuit board.

7. Ensure that the relay printed circuit board is free of contaminants. To remove contamination of organic origin, FREON is recommended. If means are taken to protect the plated printed circuit wires on the printed circuit board, rosin may be removed from the solder by sand blasting.

NOTE

Mounting of relays prior to any soldering operation is not recommended since solder flux fumes could contaminate the contacts.

8. In handling relays, the following precautions should be observed:

a. Do not attempt to adjust relay contacts. The relays are adjusted for correct contact pre-load by the manufacturer.

b. Do not trade contact assemblies from relay to relay. The manufacturer's contact pre-load adjustment takes into account manufacturing tolerances of the entire relay assembly.

c. Do not manipulate the contact assembly by hand. This may bend contacts and change the pre-load setting.

d. Do not handle the moving armature blades. This avoids contamination or bending blades out of adjustment.

e. Do not operate relay when not mounted on the printed circuit board. Back pressure on blades is required to start armature back into the magnetic field.

f. Contacts on relay and board can be cleaned by buzzing relay with AC current at rated voltage when mounted on the circuit board. This also assures proper seating of any armature dislodged in shipment.

g. Do not hand-adjust relay blades. The relays have been factory-adjusted for the required overtravel and wiping action. If the relay does not operate for any reason, replace it with another relay.

9. Remove the clear acetate cover protecting the armature and contact blades of the replacement relay.

10. Carefully insert the two terminals and mounting guides into the holes provided in the relay printed circuit board.

11. Press firmly against the top of the clip on the relay housing and insert the screwdriver blade between the clip and relay housing on one side of the relay.

12. Twist the screwdriver until the bent tip of the clip enters the adjoining hole in the relay printed circuit board and springs firmly against the base of the relay housing.

13. Perform steps 11 and 12 for the other side of the relay.

14. Attempt to insert a .003-inch shim under each corner of the relay, between a conductor and the relay seating surface. A no-go condition will indicate a properly seated relay.

DIGITAL READOUT MAINTENANCE

The digital readout assembly (figure 5-4) does not ordinarily require maintenance other than lamp bulb replacement and an occasional cleaning. Most readouts have decals on the readout cover, on the top and bottom of each readout, to show which contact is providing the signal for each digit or symbol. If decals are not provided, see figure 5-5 for information to locate each digit or symbol contact point.

Lamp Bulb Replacement

When it is determined that a digit or symbol is not illuminating within a specific readout display, the lamp bulb may be replaced by performing the following steps:

1. Remove the four Allen-head screws attaching the bezel to the DVM chassis. The readout assembly may now be withdrawn from the instrument.

2. Locate the correct contact point for the defective bulb either by noting the decal on the specific readout or by referring to figure 5-5.

3. Remove the lamp board assembly (top or bottom) from the readout containing the defective bulb by removing the two attaching screws.

4. Gently withdraw the lamp board assembly away from the lamp block within the readout cover.

5. Unsolder defective bulb and replace it with a functioning T-1 3/4 14-volt bulb.

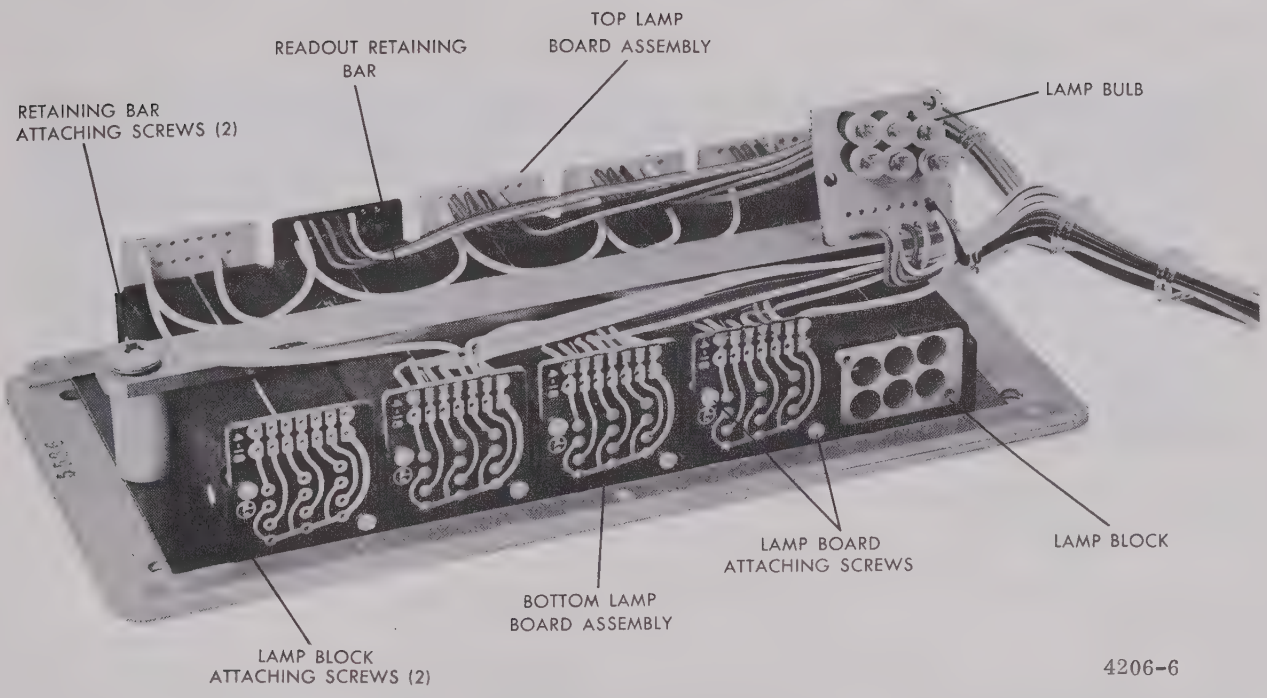


Figure 5-4. Readout Assembly

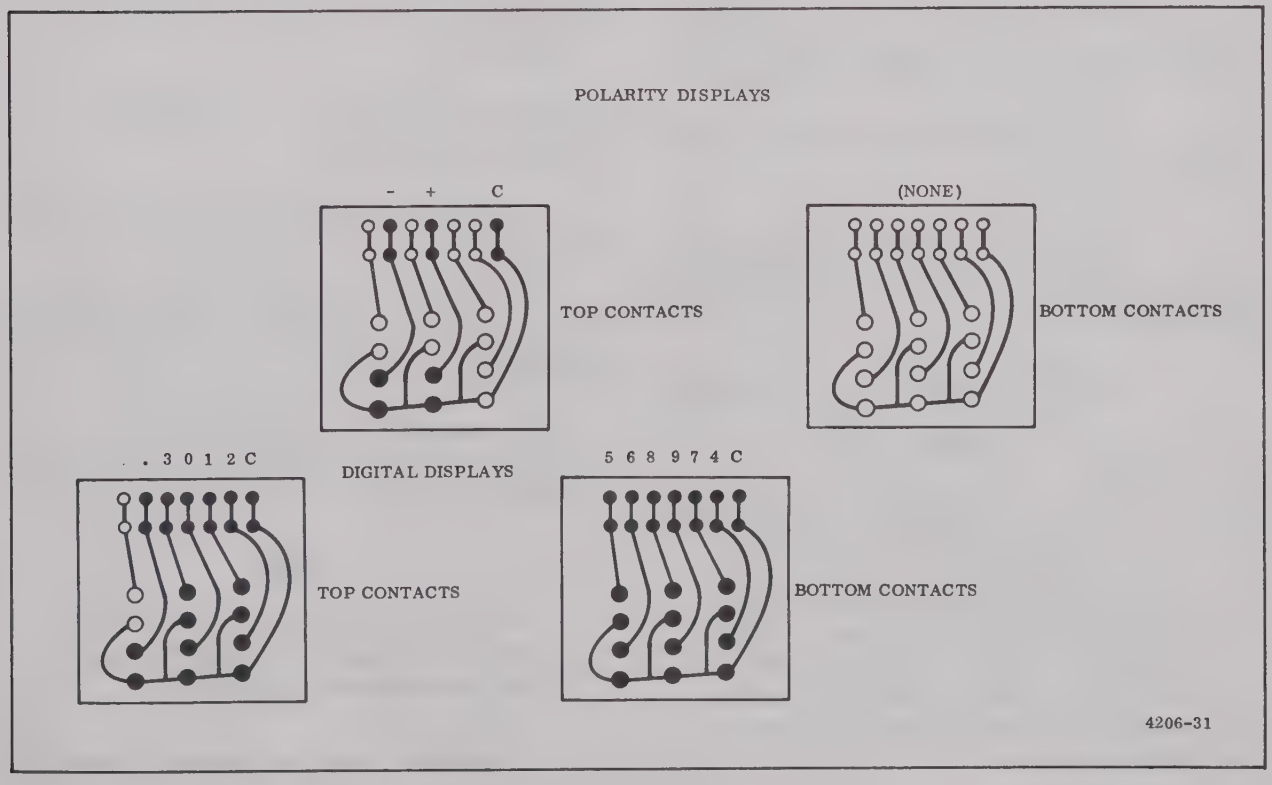


Figure 5-5. Lamp Bulb Contact Points

6. Re-assemble readout and readout assembly in reverse order of disassembly.

Readout Window Cleaning

Under extremely adverse dust or humidity conditions, the individual readout windows may require cleaning. If accumulated dust particles are likely to be unusually abrasive, a camel-hair brush or artist's sable brush should first be used to remove loose dust particles. The windows may then be cleaned with commercial isopropyl alcohol and lint-free paper, such as Kimwipes 900-L, manufactured by Kimberly-Clark, Neenah, Wisconsin. The windows may also be cleaned if they are dipped in alcohol and then blown dry with compressed air.

To remove the windows from the readout, perform the following steps:

1. Perform step No. 1 under Lamp Bulb Replacement.

2. Remove readout retaining-bar by removing two attaching screws.

3. Perform Step No.'s 3 and 4 (both top and bottom lamp boards) under Lamp Bulb Replacement for each readout to be cleaned.

4. Remove each two sets of lamp block attaching screws.

5. Gently press against one lamp block until the other lamp block may be removed and until windows can be withdrawn with finger-tip pressure.

6. Clean the windows as set forth above.

NOTE

It is well to be systematic about this operation so as to avoid replacing windows in improper order. Care should be taken to avoid replacing the windows backwards; this type of error is most likely to occur with windows marked 1, 0, 6, 8, 9, -, or +. Note that the engraved side always faces to the rear of the readout.

7. Stack the windows in proper order and press them together with mild finger-tip pressure. Avoid fingerprints on the windows. After ensuring that the numerals are right side up and that the engraved side faces the rear of the readout, gently slip the windows into the cover.

8. Re-assemble readout and readout assembly in reverse order of disassembly.

If the readout contains a Polaroid filter in front of the display, it may be removed and cleaned in the same manner as the readout windows. Care should be taken to re-install the filter so that the polarizing action is correct. Look through the filter at a piece of shiny metal, such as the chrome rim of a wrist-watch. If the metal shows a markedly violet cast, then the filter front is the surface closest to the eye.

FAN LUBRICATION

Under normal operating conditions, the ventilating fan, located on the rear of the instrument, should be lubricated with two or three drops of SAE No. 10 oil approximately every three months.

To lubricate the fan, perform the following steps (see figure 5-6).

1. Remove the four screws attaching the fan housing to the chassis of the instrument.

2. Tilt the top of the fan housing assembly away from the rear of the instrument until the fan motor is accessible.

3. Apply two or three drops of SAE No. 10 oil to lubrication opening in center of front of the fan motor.

NOTE

The first time the fan is lubricated, it will be necessary to pierce the paper seal attached to the fan motor.

4. Replace the fan housing assembly.

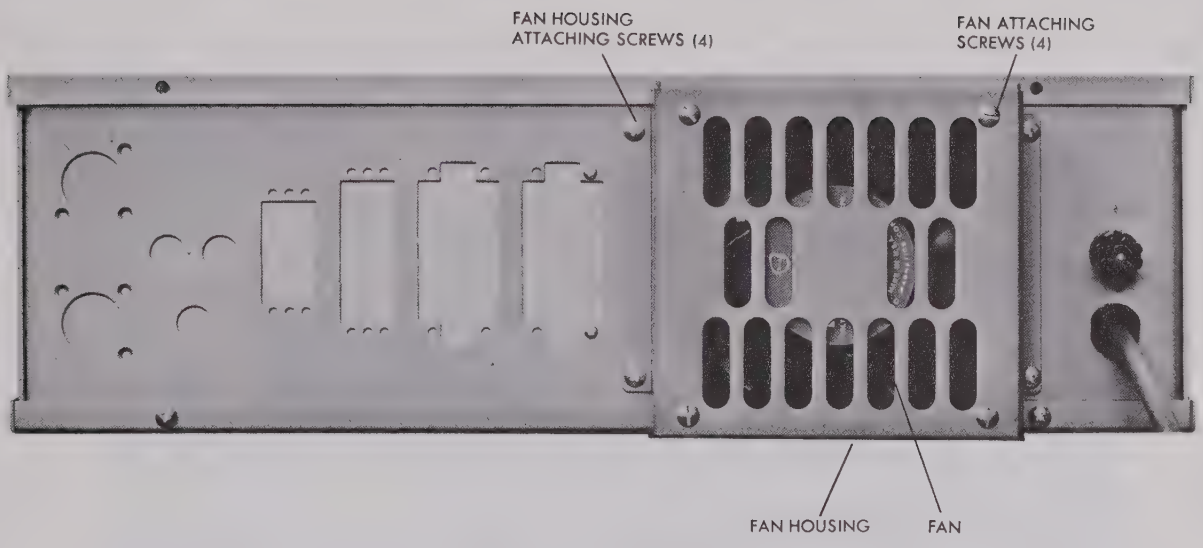


Figure 5-6. Rear View

CHAPTER VI

PARTS LIST

This chapter provides a list of electrical and electronic parts for the Models 5005 and 5010 Digital Voltmeters. The parts are called out on photographs and are listed by circuit reference. On modules that have been changed, the older and newer assemblies are both presented. These are identified by noting the number that is stamped on the printed circuit board with its effective change letter. Without exception, complete interchangeability between modules of earlier and later models is maintained.

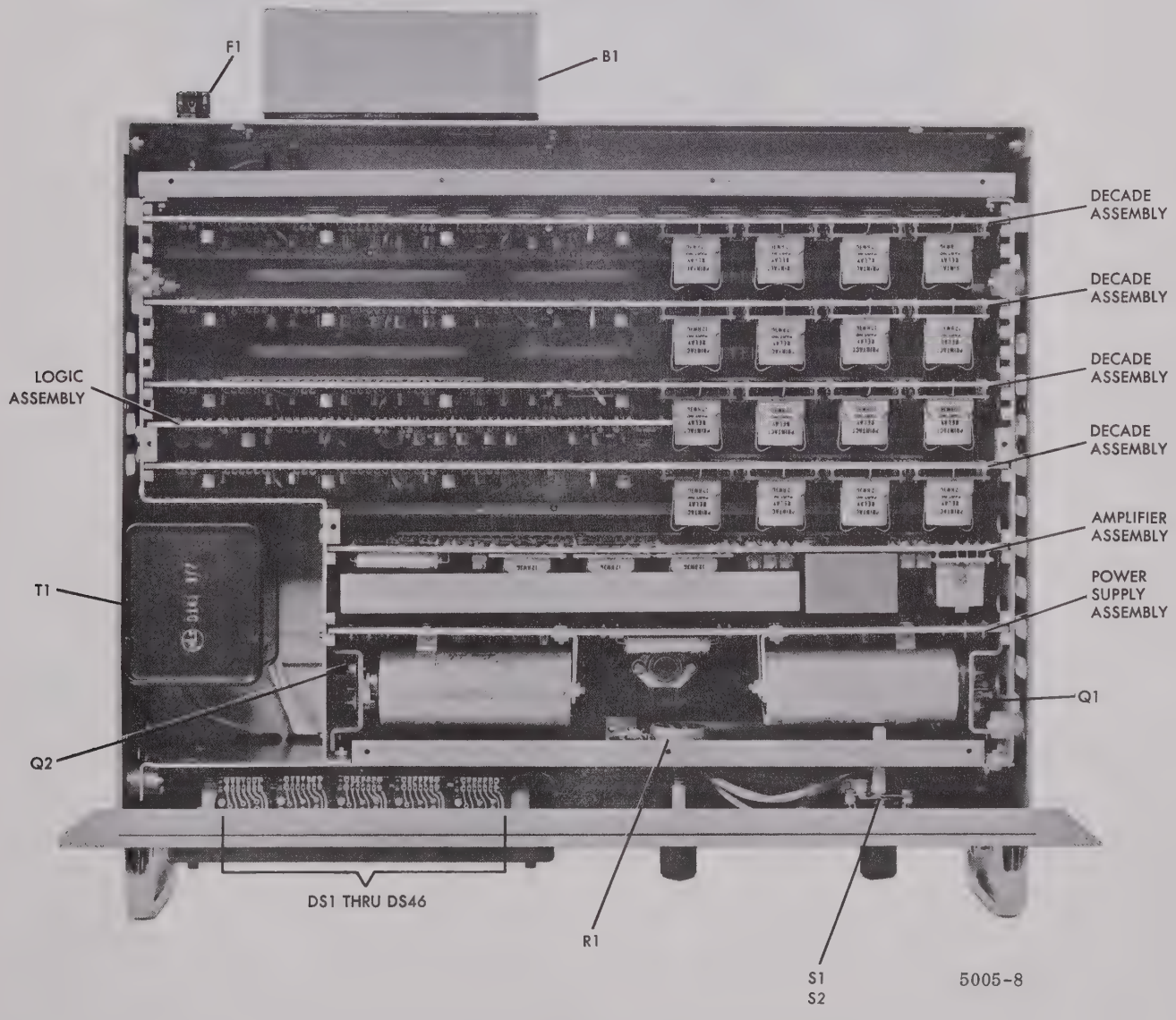


Figure 6-1. Digital Voltmeter, Top View

Digital Voltmeter, Top View

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
B1	WS2107F	FAN, BOXER	1	P.S.P. Engr. & Mfg.
DS1 thru DS46	4-19-1	BULB, LAMP	46	NLS
F1	313001	FUSE, 3AG1A, SLO-BLO	1	Littlefuse, Inc.
Q1	2N3232	TRANSISTOR	1	Silk & Transistor Corp.
Q2	2N1540	TRANSISTOR	1	Motorola
R1	50-69	POTENTIOMETER, SENS	1	NLS
S1	T-106	SWITCH, WAFER	1	Chicago Telephone
S2	50-80	SWITCH, POWER	1	NLS
T1	3-7	TRANSFORMER, POWER	1	NLS
	50-7	POWER SUPPLY ASSEMBLY	1	NLS
	50-61	DECADE ASSEMBLY (Model 5005)	4	NLS
	50-61	DECADE ASSEMBLY (Model 5010)	3	NLS
	50-114	4th DECADE ASSEMBLY (Model 5010)	1	NLS
	50-115	AMPLIFIER ASSEMBLY (Model 5005)	1	NLS
	50-64	AMPLIFIER ASSEMBLY (Model 5010)	1	NLS
	50-116	LOGIC ASSEMBLY (Model 5005)	1	NLS
	50-72	LOGIC ASSEMBLY (Model 5010)	1	NLS
	5123	CABLE ASSEMBLY (SEE FIGURE 2-1)	1	NLS

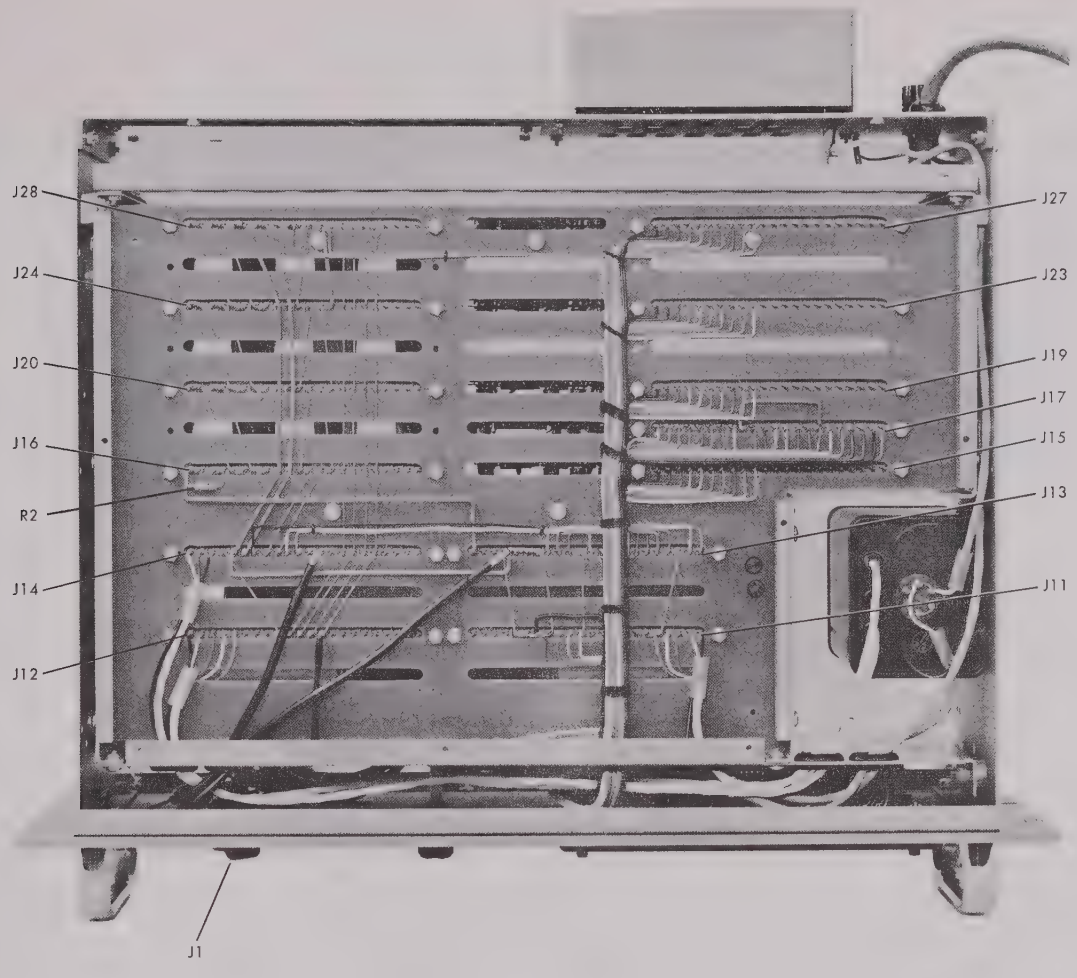


Figure 6-2. Digital Voltmeter, Bottom View

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
J1	97-3102A-14S-2P-426	CONNECTOR, INPUT	1	Amphenol
J11 thru J17, J19, J20, J23, J24, J27 & J28	00-5009-022-153-002	CONNECTOR, 22-PIN	13	ELCO
R2	GP 1/2	RESISTOR, 100K, 1/2W, 1%	1	Texas Instruments

NOTE: Serial No. .641 and on, J1 is deleted and J2 is installed on rear of instrument (same part number).

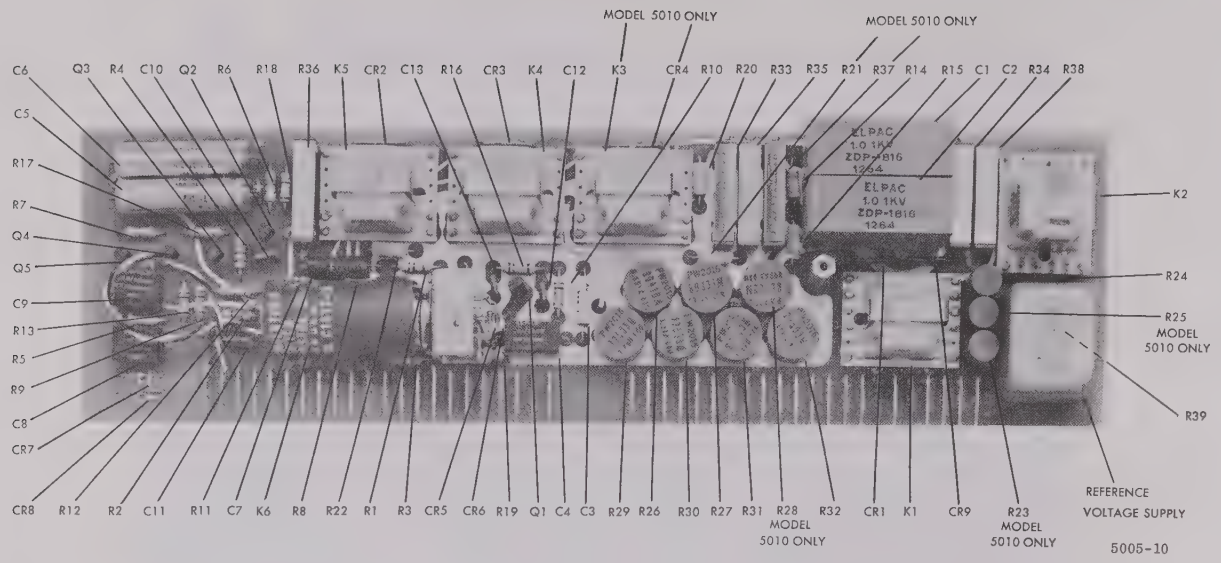


Figure 6-3. Amplifier Assembly, 50-64 (Model 5010)
Amplifier Assembly, 50-115 (Model 5005)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
C1 & C2	ZDP1816	CAPACITOR, 1.0 MFD, 1000V	2	Elpac, Inc.
C3	PD1A102K	CAPACITOR, 0.001 MFD, 100V	1	Elpac, Inc.
C4	PD1X103	CAPACITOR, 0.01 MFD, 100V	1	Elpac, Inc.
C5 & C6	TE-1211	CAPACITOR, 100 MFD, 25V	2	Sprague Products
C7	PTT-77	CAPACITOR, 5 MFD, 25V	1	Aerovox Corp.
C8 & C9	VX1X254K	CAPACITOR, 0.25 MFD, 100V	2	Elpac, Inc.
C10	DD250	CAPACITOR, 25 PF, 1000V	1	Centralab
C11	ZX2X473K	CAPACITOR, 0.047 MFD, 200V	1	Elpac, Inc.
C12 & C13	RMC1500	CAPACITOR, 50 PF, 1000V	2	Radio Materials Co.
CR1 thru CR8	5003-002	DIODE	8	NLS
CR9	1N756	DIODE, ZENER	1	Motorola
K1 thru K5	5005-006	RELAY, PRINTACT	5	NLS
K6	C1417-27	CHOPPER	1	The Bristol Co.
Q1 thru Q5	2N3711	TRANSISTOR	5	Texas Instruments
R1	GP 1/2	RESISTOR, 30 ohms, 1/2W, 1%	1	Texas Instruments
R2	GP 1/2	RESISTOR, 36 ohms, 1/2W, 1%	1	Texas Instruments
R3	GP 1/2	RESISTOR, 180 ohms, 1/2W, 1%	1	Texas Instruments

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
R4	GP 1/2	RESISTOR, 270 ohms, 1/2W, 1%	1	Texas Instruments
R5	GP 1/2	RESISTOR, 330 ohms, 1/2W, 1%	1	Texas Instruments
R6 & R7	GP 1/2	RESISTOR, 360 ohms, 1/2W, 1%	2	Texas Instruments
R8	GP 1/2	RESISTOR, 430 ohms, 1/2W, 1%	1	Texas Instruments
R9 & R10	GP 1/2	RESISTOR, 1K, 1/2W, 1%*	2	Texas Instruments
R11	GP 1/2	RESISTOR, 1.2K, 1/2W, 1%	1	Texas Instruments
R12	GP 1/2	RESISTOR, 6.8K, 1/2W, 1%	1	Texas Instruments
R13 thru R15 & R19	GP 1/2	RESISTOR, 10K, 1/2W, 1%	4	Texas Instruments
R16 & R17	GP 1/2	RESISTOR, 12K, 1/2W, 1%	2	Texas Instruments
R18	GP 1/2	RESISTOR, 20K, 1/2W, 1%	1	Texas Instruments
R20 thru R22	GP 1/2	RESISTOR, 910K, 1/2W, 1%	3	Texas Instruments
R23	PW1220	RESISTOR, 11.111K, 1/2W, 0.01%	1	NLS
R24	PW1220	RESISTOR, 20K, 1/2W, 0.05%	1	NLS
R25	PW1220	RESISTOR, 90K, 1/2W, 0.01%	1	NLS
R26	PW2016	RESISTOR, 9.991K, 1/2W, 0.05%*	1	NLS
R27	PW2016	RESISTOR, 89.9K, 1/2W, 0.05%*	1	NLS
R28	PW2016	RESISTOR, 899K, 1/2W, 0.05%	1	NLS
R29 thru R32	PW2016	RESISTOR, 2.25 Megohms, 1/2W, 0.05%	4	NLS
R33	75P-R20	POTENTIOMETER, 20 ohms (Wire Wound)*	1	Helipot
R34 thru R36	75P-R200	POTENTIOMETER, 200 ohms (Wire Wound)*	3	Helipot
R37	75P-R2K	POTENTIOMETER, 2K (Wire Wound)	1	Helipot
R38	75P-R20K	POTENTIOMETER, 20K (Wire Wound)	1	Helipot
R39	CEC-TO	RESISTOR, 28.7K, 1/2W, 1%	1	IRC
	2-11	REFERENCE VOLTAGE SUPPLY	1	NLS

*NOTE: Resistors and resistor values listed are for Model 5010 only. See below for Model 5005.

R10	GP 1/2	RESISTOR, 20K, 1/2W, 1%	1	Texas Instruments
R26	PW2016	RESISTOR, 99.111K, 1/2W, 0.05%	1	NLS
R27	PW2016	RESISTOR, 890K, 1/2W, 0.05%	1	NLS
R33	75P-R2K	POTENTIOMETER, 2K, (Wire Wound)	1	Helipot
R35	75P-R20K	POTENTIOMETER, 20K, (Wire Wound)	1	Helipot

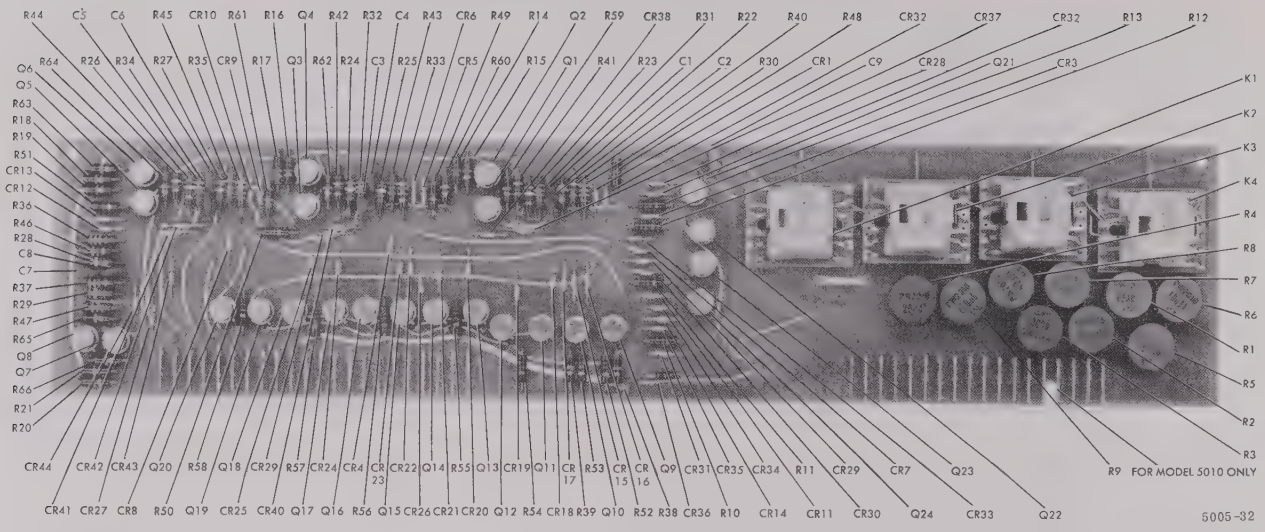


Figure 6-4. 4th Decade Assembly, 50-114 (Model 5010)
Decade Assembly, 50-61 (Models 5005 and 5010)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
C1 thru C8	DDM-103	CAPACITOR, 0.01 MFD, 150V	8	Centralab
C9	B.002	CAPACITOR, 0.002 MFD, 150V	1	Radio Materials
CR1 thru CR35 & CR37 thru CR44	5003-002	DIODE	43	NLS
CR36	1N756	DIODE, ZENER	1	Motorola
K1 thru K4	5005-006	RELAY, PRINTACT	4	NLS Inc.
Q1 thru Q20	2N1305	TRANSISTOR	20	Texas Instruments
Q21 thru Q24	2N1304	TRANSISTOR	4	Texas Instruments
R1 & R6	PW2016	RESISTOR, 10K, 1/2W, 0.01%*	2	NLS
R2, R4, R7 & R9	PW2016	RESISTOR, 20K, 1/2W, 0.01%*	4	NLS
R3 & R8	PW2016	RESISTOR, 40K, 1/2W, 0.01%*	2	NLS
R5	PW2016	RESISTOR, 11.111K, 1/2W, 0.05%	1	NLS
R10 thru R13	Com'l	RESISTOR, 2.2K, 1/2W, 10% (Carbon)	4	

*NOTE: On the 4th Decade Assembly for Model 5010 only (Part No. 50-114), Accuracy is ±0.005%, matched to 0.0025%. Temp. coefficient 0-50 PPM, all in the same direction. Must be ordered as a matched set.

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
R14 thru R21	Com'l	RESISTOR, 15K, 1/2W, 5% (Carbon)	8	
R22 thru R29	Com'l	RESISTOR, 3.9K, 1/2W, 5% (Carbon)	8	
R30 thru R37	Com'l	RESISTOR, 47K, 1/2W, 5% (Carbon)	8	
R38, R39, & R59 thru R66	Com'l	RESISTOR, 10K, 1/2W, 5% (Carbon)	10	
R40 thru R47	Com'l	RESISTOR, 2.7K, 1/2W, 5% (Carbon)	8	
R48 thru R51	Com'l	RESISTOR, 1K, 1/2W, 5% (Carbon)	4	
R52 thru R58	Com'l	RESISTOR, 5.6K, 1/2W, 5% (Carbon)	7	

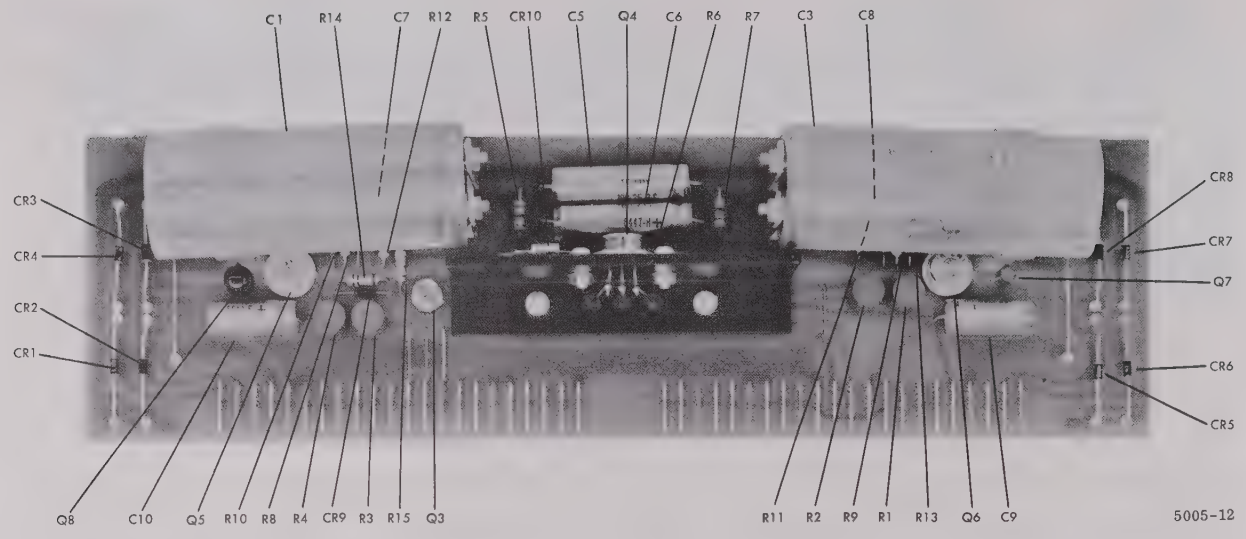


Figure 6-5. Power Supply Assembly, 50-7

See Notes Below

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
C1 & C3	1B1546	CAPACITOR, 2000 MFD, 50V (See Note 1)	2	Industrial Condenser
C5 & C6	TE1211	CAPACITOR, 100 MFD, 25V	2	Sprague Products
C7 & C8	BT005	CAPACITOR, 0.005 MFD, 100V	2	Radio Materials Co.
C9 & C10	TE1162	CAPACITOR, 100 MFD, 15V	2	Sprague Products
CR1 thru CR8	1N4005	DIODE	8	Motorola
CR9	1N758A	DIODE	1	Cont. Devices
CR10	1N3827	DIODE	1	Motorola
Q3	2N1305	TRANSISTOR	1	Texas Instruments
Q4 & Q6	2N1701	TRANSISTOR	2	RCA
Q5	2N1183	TRANSISTOR	1	RCA
Q7	2N3711	TRANSISTOR	1	Texas Instruments
Q8	2N3702	TRANSISTOR	1	Texas Instruments
R1 thru R4	PW1220	RESISTOR, 2.4K, 1/2W, 1%	4	NLS
R5 & R7	Com'l	RESISTOR, 390 ohms, 1/2W, 5% (Carbon)	2	
R6	Com'l	RESISTOR, 300 ohms, 1/2W, 5% (Carbon)	1	

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
R8 thru R11	Com'l	RESISTOR, 1K, 1/2W, 5% (Carbon)	4	
R12 & R13	Com'l	RESISTOR, 10 ohms, 1/2W, 5% (Carbon)	2	
R14	Com'l	RESISTOR, 10K, 1/2W, 5% (Carbon)	1	
R15	Com'l	RESISTOR, 680 ohms, 1/2W, 5% (Carbon)	1	
	NOTES:			
	1. Alternates are:			
C1 thru C4	1B1645	CAPACITOR, 1000 MFD, 25V	4	Industrial Condenser
C1 thru C4	71EZ25SH13	CAPACITOR, 1000 MFD, 25V	4	Safe-T-Mike Corp.
	2. This photograph represents Power Supply Assembly that is stamped 50-5 (C) and prior change letter (see Schematic 50-7 "A" change).			

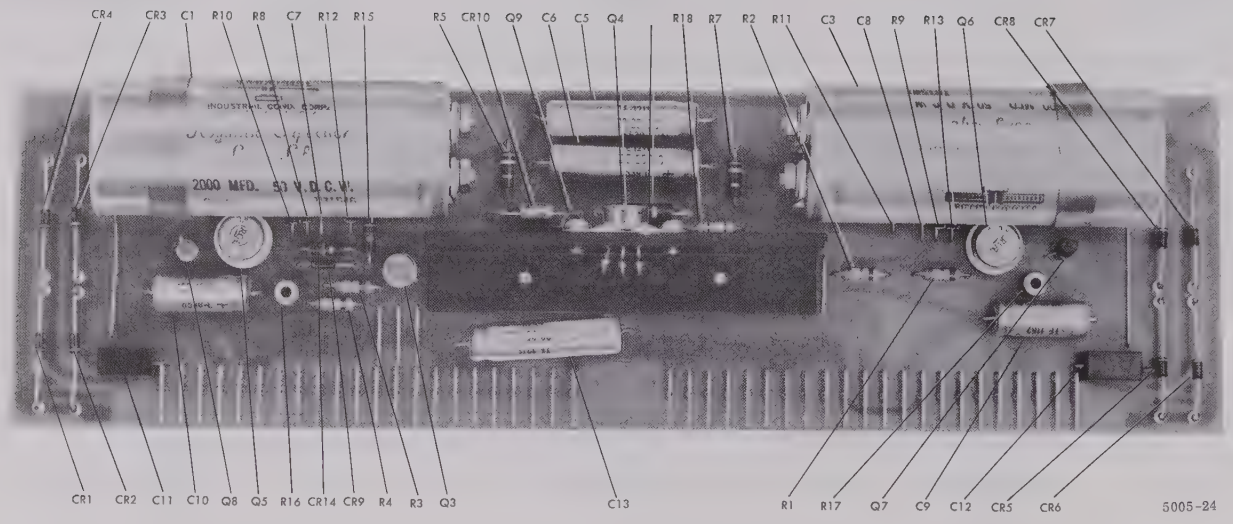
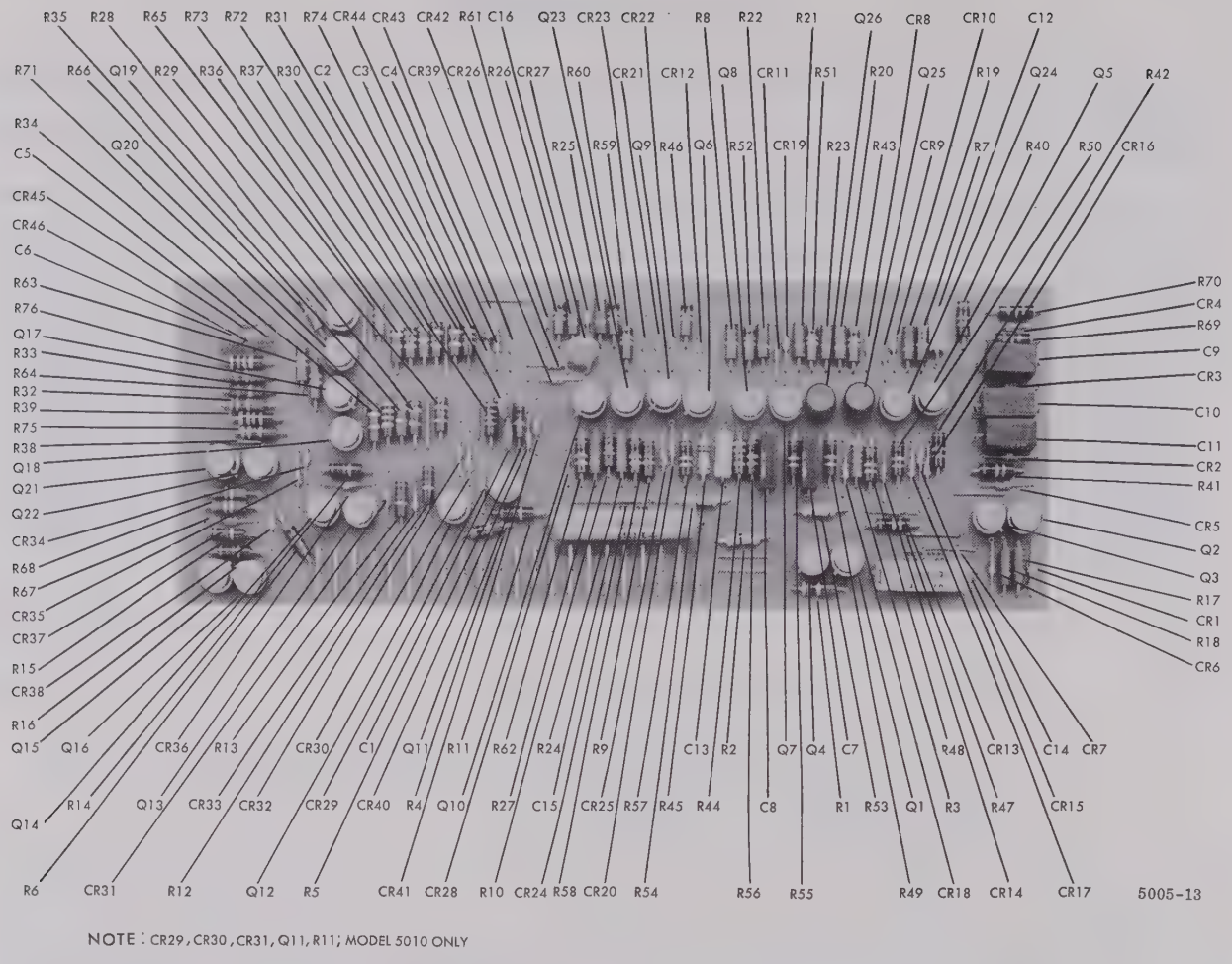


Figure 6-6. Power Supply Assembly, 50-7

See Notes Below

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
C1 & C3	1B1546	CAPACITOR, 2000 MFD, 50V (See Note 1)	2	Industrial Condenser
C5, C6 & C13	TE1211	CAPACITOR, 100 MFD, 25V	3	Sprague Products
C7 & C8	BT005	CAPACITOR, 0.005 MFD, 100V	2	Radio Materials Co.
C9 & C10	TE1162	CAPACITOR, 100 MFD, 15V	2	Sprague Products
C11 & C12	VX1X254K	CAPACITOR, 0.25 MFD, 100V	2	Elpac, Inc.
CR1 thru CR8	1N4005	DIODE	8	Motorola
CR9	1N758A	DIODE	1	Cont. Devices
CR10	1N3827	DIODE	1	Motorola
Q3	2N1305	TRANSISTOR	1	Texas Instruments
Q4 & Q6	2N1701	TRANSISTOR	2	RCA
Q5	2N1183	TRANSISTOR	1	RCA
Q7	2N3711	TRANSISTOR	1	Texas Instruments
Q8	2N3702	TRANSISTOR	1	Texas Instruments
Q9	2N3711	TRANSISTOR	1	Texas Instruments
R1 thru R4	PW1220	RESISTOR, 2.4K, 1/2W, 1%	4	NLS
R5 & R7	Com'l	RESISTOR, 390 ohms, 1/2W, 5% (Carbon)	2	
R6	Com'l	RESISTOR, 300 ohms, 1/2W, 5% (Carbon)	1	

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
R8 thru R11	Com'l	RESISTOR, 1K, 1/2W, 5% (Carbon)	4	
R12 & R13	Com'l	RESISTOR, 10 ohms, 1/2W, 5% (Carbon)	2	
R14	Com'l	RESISTOR, 10K, 1/2W, 5% (Carbon)	1	
R15	Com'l	RESISTOR, 680 ohms, 1/2W, 5% (Carbon)	1	
R16 & R17	62P-R500	POTENTIOMETER, 500 ohms	2	Helipot
R18	Com'l	RESISTOR, 100K, 1/2W, 5% (Carbon)	1	
	NOTES:			
	1. Alternates are:			
C1 thru C4	1B1645	CAPACITOR, 1000 MFD, 25V	4	Industrial Condenser
C1 thru C4	71EZ25SH13	CAPACITOR, 1000 MFD, 25V	4	Safe-T-Mike Corp.
	2. This photograph represents Power Supply Assembly that is stamped 50-5 (E) (see Schematic 50-7 "E" change).			



NOTE : CR29, CR30, CR31, Q11, R11; MODEL 5010 ONLY

Figure 6-7. Logic Assembly, 50-72 (Model 5010)
Logic Assembly, 50-116 (Model 5005)

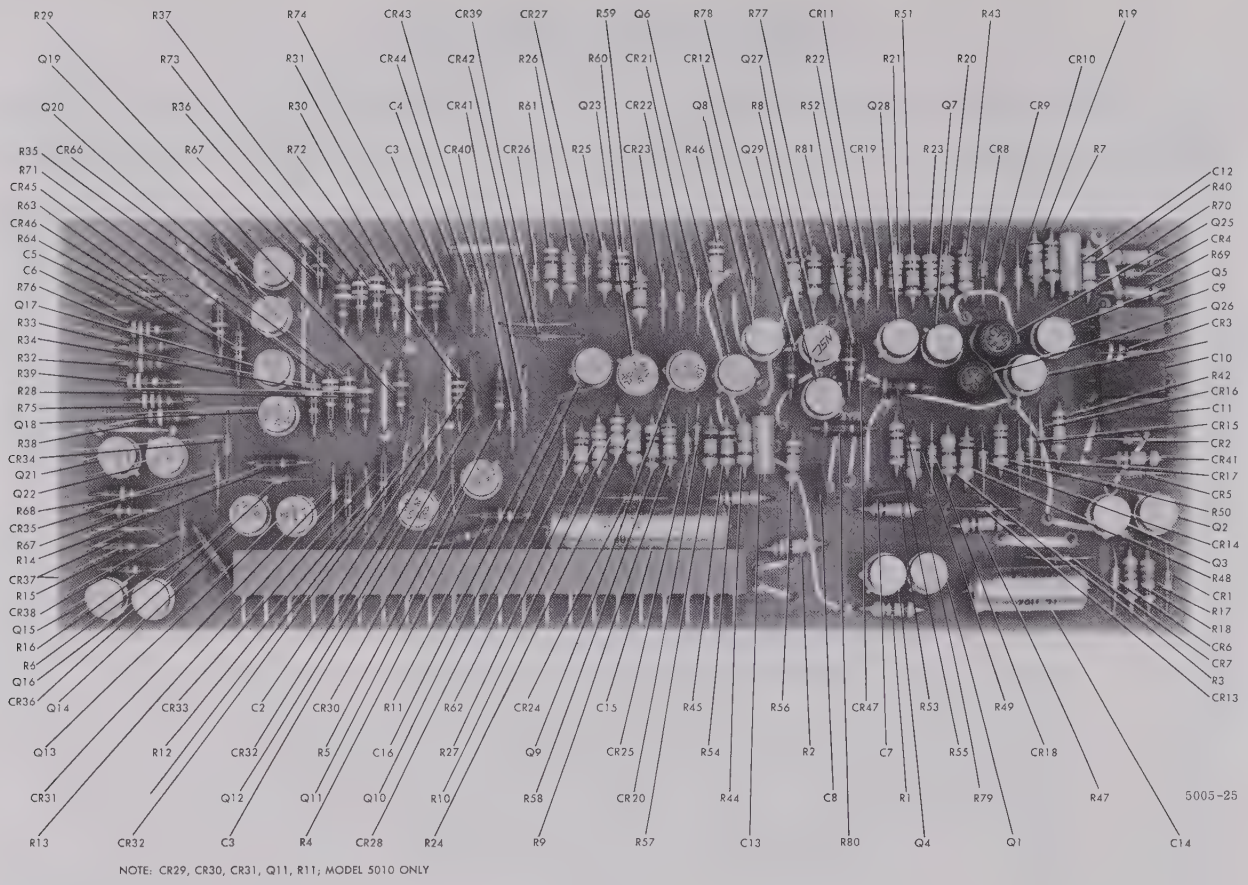
See Note Below

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
C1 thru C6	PD1J103	CAPACITOR, 0.01 MFD, 100V	6	Elpac, Inc.
C7 & C8	ZX2X473K	CAPACITOR, 0.047 MFD, 200V	2	Elpac, Inc.
C9 thru C11	VX1X254K	CAPACITOR, 0.025 MFD, 200V	3	Elpac, Inc.
C12 & C13	CS13AF2R2M	CAPACITOR, 2.2 MFD, 10%	2	Mallory
C14	TE1162	CAPACITOR, 100 MFD, 15V	1	Sprague Products
C15	TE1211	CAPACITOR, 100 MFD, 25V	1	Sprague Products
C16	DDM-103	CAPACITOR, 0.01 MFD, 150V	1	Centralab

Logic Assembly, 50-72 (Model 5010)
Logic Assembly, 50-116 (Model 5005)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
CR1 thru CR46	5003-002	DIODE	46	NLS
Q1 thru Q22	2N1305	TRANSISTOR	22	Texas Instruments
Q23	2N1304	TRANSISTOR	1	Texas Instruments
Q24	2N697	TRANSISTOR	1	Texas Instruments
Q25 & Q26	3N58	SCS	2	General Electric
R1	Com'l	RESISTOR, 47 ohms, 1/2W, 5% (Carbon)	1	
R2	Com'l	RESISTOR, 56 ohms, 1/2W, 5% (Carbon)	1	
R3	Com'l	RESISTOR, 470 ohms, 1/2W, 5% (Carbon)	1	
R4 thru R6	Com'l	RESISTOR, 1K, 1/2W, 5% (Carbon)	1	
R7	Com'l	RESISTOR, 1.2K, 1/2W, 5% (Carbon)	1	
R8 thru R16	Com'l	RESISTOR, 1.5K, 1/2W, 5% (Carbon)	9	
R17 thru R27	Com'l	RESISTOR, 2.2K, 1/2W, 5% (Carbon)	11	
R28 thru R33	Com'l	RESISTOR, 2.7K, 1/2W, 5% (Carbon)	6	
R34 thru R39	Com'l	RESISTOR, 3.9K, 1/2W, 5% (Carbon)	6	
R40 & R41	GP 1/2	RESISTOR, 10K, 1/2W, 5%	2	Texas Instruments
R42, R43 & R45 thru R62	Com'l	RESISTOR, 10K, 1/2W, 5% (Carbon)	20	
R44	GP 1/2	RESISTOR, 4.3K, 1/2W, 1%	1	Texas Instruments
R63 thru R68	Com'l	RESISTOR, 15K, 1/2W, 5% (Carbon)	6	
R69 & R70	GP 1/2	RESISTOR, 51K, 1/2W, 1%	2	Texas Instruments
R71 thru R76	Com'l	RESISTOR, 47K, 1/2W, 1% (Carbon)	6	

NOTE: This photograph represents Logic Assembly that is stamped 50-70 (B) and prior change letter (see Schematic 50-72 "C" change - Model 5010 and Schematic 50-116 "A" change - Model 5005).



NOTE: CR29, CR30, CR31, Q11, R11; MODEL 5010 ONLY

Figure 6-8. Logic Assembly, 50-72 (Model 5010 As Shown Above)
Logic Assembly, 50-116 (Model 5005)

See Note Below

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
C1 thru C8 & C16	DDM-103	CAPACITOR, 0.01 MFD, 100V	9	Centralab
C9 thru C11	VX1X254K	CAPACITOR, 0.025 MFD, 200V	3	Elpac, Inc.
C12 & C13	CS13AF2R2M	CAPACITOR, 2.2 MFD, 10%	2	Mallory
C14	TE1162	CAPACITOR, 100 MFD, 15V	1	Sprague Products
C15	TE1211	CAPACITOR, 100 MFD, 25V	1	Sprague Products
CR1 thru CR47	5003-002	DIODE	47	NLS

Logic Assembly, 50-72 (Model 5010 As Shown Above)
Logic Assembly, 50-116 (Model 5005)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
Q1 thru Q22, Q28 & Q29	2N1305	TRANSISTOR	24	Texas Instruments
Q23	2N1304	TRANSISTOR	1	Texas Instruments
Q24 & Q27	2N697	TRANSISTOR	1	Texas Instruments
Q25 & Q26	3N58	SCS	2	General Electric
R1	Com'l	RESISTOR, 47 ohms, 1/2W, 5% (Carbon)	1	
R2	Com'l	RESISTOR, 56 ohms, 1/2W, 5% (Carbon)	1	
R3	Com'l	RESISTOR, 470 ohms, 1/2W, 5% (Carbon)	1	
R4 thru R6	Com'l	RESISTOR, 1K, 1/2W, 5% (Carbon)	1	
R7	Com'l	RESISTOR, 1.2K, 1/2W, 5% (Carbon)	1	
R8 thru R16	Com'l	RESISTOR, 1.5K, 1/2W, 5% (Carbon)	9	
R17 thru R27	Com'l	RESISTOR, 2.2K, 1/2W, 5% (Carbon)	11	
R28 thru R33	Com'l	RESISTOR, 2.7K, 1/2W, 5% (Carbon)	6	
R34 thru R39	Com'l	RESISTOR, 3.9K, 1/2W, 5% (Carbon)	6	
R40, R41 & R77	GP 1/2	RESISTOR, 10K, 1/2W, 5%	3	Texas Instruments
R42, R43 & R45 thru R62	Com'l	RESISTOR, 10K, 1/2W, 5% (Carbon)	20	
R44	GP 1/2	RESISTOR, 4.3K, 1/2W, 1%	1	Texas Instruments
R63 thru R68	Com'l	RESISTOR, 15K, 1/2W, 5% (Carbon)	6	
R69 & R70	GP 1/2	RESISTOR, 68K, 1/2W, 1%	2	Texas Instruments
R71 thru R76	Com'l	RESISTOR, 47K, 1/2W, 1% (Carbon)	6	
R78 thru R80	Com'l	RESISTOR, 3K, 1/2W, 5% (Carbon)	3	
R81	Com'l	RESISTOR, 22K, 1/2W, 5% (Carbon)	1	

NOTE:

1. This photograph represents Logic Assembly that is stamped 50-70 (C) (see Schematic 50-72 "G" change - Model 5010 and Schematic 50-116, "E" change - Model 5005).

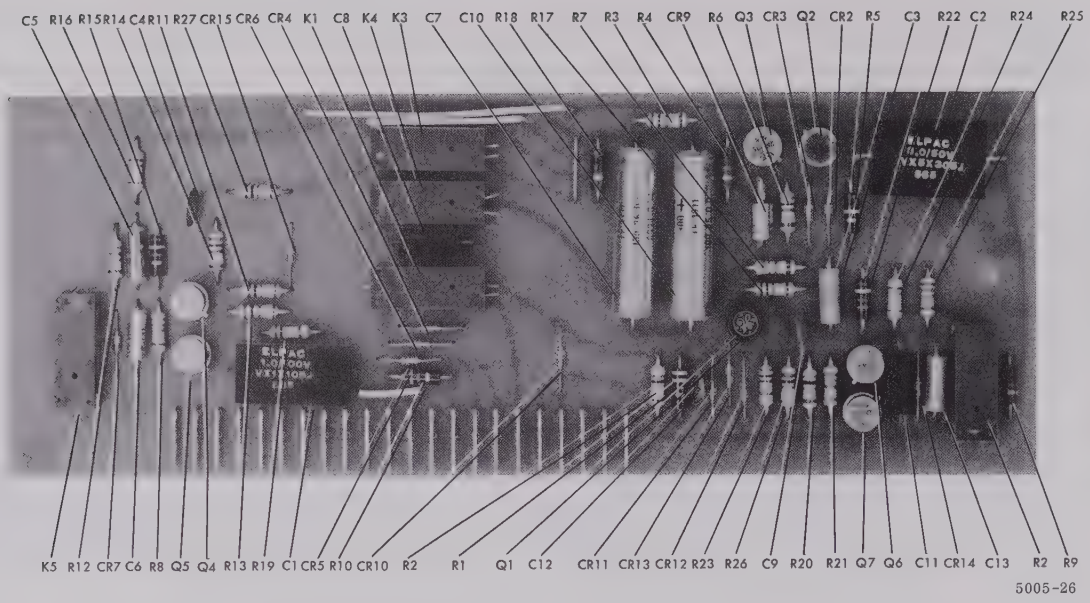


Figure 6-9. Print Control Assembly — DVL-1, 50-67 (Optional)

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
C1	VXJ-2763J	CAPACITOR, 1.0 MFD	1	Elpac, Inc.
C2	VX5X305J	CAPACITOR, 3.0 MFD/100V	1	Elpac, Inc.
C3	CS13AF2R2M	CAPACITOR, 2.2 MFD	1	P. R. Mallory & Co.
C4 & C9	DDM 103	CAPACITOR, .01 MFD	2	Elpac, Inc.
C5 & C6	CS13AF5R6K	CAPACITOR, 5.6 MFD	2	P. R. Mallory & Co.
C7 & C10	TE1211	CAPACITOR, 100 MFD/25V	2	Sprague Products
C8	VX1X334	CAPACITOR, .33 MFD/100V	1	Elpac, Inc.
C11	VX1X154	CAPACITOR, 0.15 MFD/50V	1	Elpac, Inc.
C12	DD201	CAPACITOR, 200 PFD	1	Elpac, Inc.
C13	CS132R2K	CAPACITOR, 2.2 MFD/ELECTROLYTIC	1	P. R. Mallory & Co.
CR2 thru CR7 & CR10 thru CR15	5003-002	DIODE	12	NLS
CR9	1N3022B	DIODE, ZENER	1	Motorola
K1 thru K5	5-12-34	RELAY	5	NLS
Q1	3N58	SILICON CONTROLLED SWITCH	1	General Electric
Q2	2N697	TRANSISTOR	1	Texas Instruments

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY	MANUFACTURER
Q3	2N1305	TRANSISTOR	1	Texas Instruments
Q4 thru Q7	2N1304	TRANSISTOR	4	Texas Instruments
R1	Com'l	RESISTOR, 4.7K, 1/2W, 5%	1	
R2, R19	Com'l	RESISTOR, 100K, 1/2W, 5%	2	
R3, R13, R23	Com'l	RESISTOR, 100 ohm, 1/2W, 5%	3	
R4	Com'l	RESISTOR, 5.6K, 1/2W, 5%	1	
R5	Com'l	RESISTOR, 200K, 1/2W, 5%	1	
R6, R14, R20	Com'l	RESISTOR, 2K, 1/2W, 5%	3	
R7, R8, R21	Com'l	RESISTOR, 6.2K, 1/2W, 5%	3	
R9, R11, R17, R26, R27	Com'l	RESISTOR, 1K, 1/2W, 5%	5	
R10	Com'l	RESISTOR, 6.8K, 1/2W, 5%	1	
R12, R25	Com'l	RESISTOR, 1.2K, 1/2W, 5%	2	
R15, R22	Com'l	RESISTOR, 2.4K, 1/2W, 5%	2	
R16, R24	Com'l	RESISTOR, 120K, 1/2W, 5%	2	
R18	Com'l	RESISTOR, 200 ohm, 1/2W, 5%	1	

CHAPTER VII

RECOMMENDED SPARE PARTS LIST

This chapter lists the spare parts level which is recommended to be stocked for the maintenance of five Model 5005 or 5010 Digital Voltmeters. If it is desired to know the name of the manufacturer, check this list against the list in chapter 6. For up-to-date price information, check with your service representative or contact the NLS home office.

PART NO.	DESCRIPTION	RECOMMENDED SPARES
50-64	AMPLIFIER ASSEMBLY (Model 5010)	1
50-115	AMPLIFIER ASSEMBLY (Model 5005)	1
50-61	DECADE ASSEMBLY (Models 5005 and 5010)	1
50-114	4th DECADE ASSEMBLY (Model 5010)	1
50-72	LOGIC ASSEMBLY (Model 5010)	1
50-116	LOGIC ASSEMBLY (Model 5005)	1
50-7	POWER SUPPLY ASSEMBLY (Model 5005 and 5010)	1
ZDP1816	CAPACITOR, 1.0 MFD, 1000V	1
TE-1211	CAPACITOR, 100 MFD, 25V	2
PTT-77	CAPACITOR, 5 MFD, 25V	1
1B1546	CAPACITOR, 2000 MFD, 50V	1
CS13AF2R2M	CAPACITOR, 2.2 MFD, 10%	2
TE1162	CAPACITOR, 100 MFD, 15V	1
TE1211	CAPACITOR, 100 MFD, 25V	1
C1417-27	CHOPPER	1
5003-002	DIODE	24
1N963B	DIODE, ZENER	1
1N758A	DIODE	1
1N3827	DIODE	1
1N756	DIODE, ZENER	1
WS2107F	FAN, BOXER	1
313001	FUSE, 3AG1A, SLO-BLO	6
T-1 3/4	LAMP BULB	10
75P-R20	POTENTIOMETER, 20 OHMS (Wire Wound)	1
75P-R200	POTENTIOMETER, 200 OHMS (Wire Wound)	1
75P-R2K	POTENTIOMETER, 2K (Wire Wound)	1
75P-R20K	POTENTIOMETER, 20K (Wire Wound)	1
50-69	POTENTIOMETER, SENS	1
PW1220	RESISTOR, 1.111K, 1/2W, 0.01%	1
PW1220	RESISTOR, 20K, 1/2W, 0.05%	1
PW1220	RESISTOR, 90K, 1/2W, 0.01%	1
PW2016	RESISTOR, 9.991K, 1/2W, 0.05%	1
PW2016	RESISTOR, 89.9K, 1/2W, 0.05%	1
PW2016	RESISTOR, 899K, 1/2W, 0.05%	1
PW2016	RESISTOR, 2.25 MEGOHMS, 1/2W, 0.05%	2
GP 1/2	RESISTOR, 100K, 1/2W, 1%	1
PW2016	RESISTOR, 10K, 1/2W, 0.01%*	2
PW2016	RESISTOR, 20K, 1/2W, 0.01%*	4

PART NO.	DESCRIPTION	RECOMMENDED SPARES
PW2016	RESISTOR, 40K, 1/2W, 0.01%*	2
PW2016	RESISTOR, 11.111K, 1/2W, 0.05%	1
PW1220	RESISTOR, 2.4K, 1/2W, 1%	2
T-106	SWITCH, WAFER	1
3-7	TRANSFORMER, POWER	1
2N3711	TRANSISTOR	6
2N3232	TRANSISTOR	1
2N1540	TRANSISTOR	1
2N1701	TRANSISTOR	1
2N1183	TRANSISTOR	1
2N3702	TRANSISTOR	2
2N697	TRANSISTOR	2

*NOTE: On the 4th Decade Assembly for Model 5010 (Part No. 50-114) accuracy is ±0.005%, matched to 0.0025%. Temperature coefficient 0-50 PPM, all in the same direction. Must be ordered and installed as a set.

APPENDIX

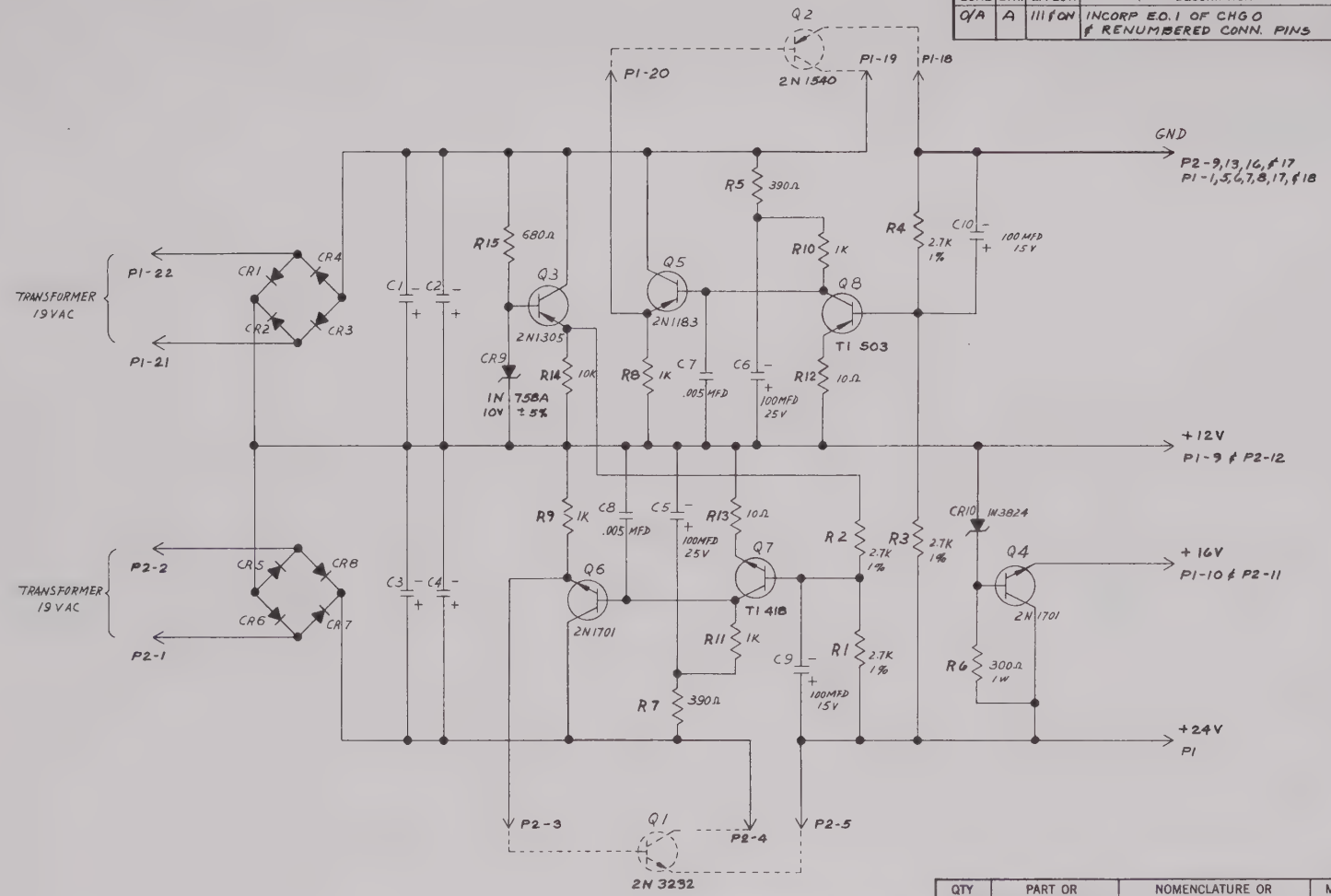
SHIPPING INSTRUCTIONS

Depending upon location, the choice of carrier will vary. Never ship an instrument to us without having received shipping instructions. If requested, an estimate of charges can be made before work begins.

Be certain to pack the instrument carefully; while an outer and inner box, separated by two or three inches of excelsior is desirable, the instrument can be placed into a single container provided it is so packed that it will not shift about. As with the double box method, use two or three inches of shock-absorbent packing materials. The instrument itself should be first wrapped in heavy paper so as to keep excelsior or other particles from entering the instrument's louvers. If the original shipping container is in good condition, it may be used.

CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it does not operate or is damaged, a claim should be made with the carrier. The claim agent should receive a full report of damage, and this report sent to Non-Linear Systems, Inc. After receiving such a report we will advise you of the disposition of the instrument and arrange for its repair or replacement. Be certain to include model and serial number when corresponding.



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
C/A	A	111 f ON	INCORP E.O. 1 OF CHG 0 & RENUMBERED CONN. PINS	5-13-65 MAY	R.T.W.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

6. Q8 - 2N3638 TRANSISTOR MAY BE USED IN LIEU OF T1503 PROVIDED A MIN BETA OF 60 IS MAINTAINED.
5. RESISTORS ARE ½ W. CARBON 5% TOL. UNLESS OTHERWISE SPECIFIED
4. R1 THRU R4 ARE PW1220 1% W W
3. Q1 AND Q2 ARE MOUNTED ON INNER CHASSIS
2. C1 THRU C4 ARE 1000 MFD/25V
1. CR1 THRU CR8 ARE T14385 OR MOTOROLA IN4003

NOTES:

50-17	50-17	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

MATERIAL

CONTR. NO.

DRAWN	LAM	12/2/64
CHECK	[illegible]	2-2-65
APPR	R. Wm Smith	2-2-65
RELEASE DATE	2-2-65	

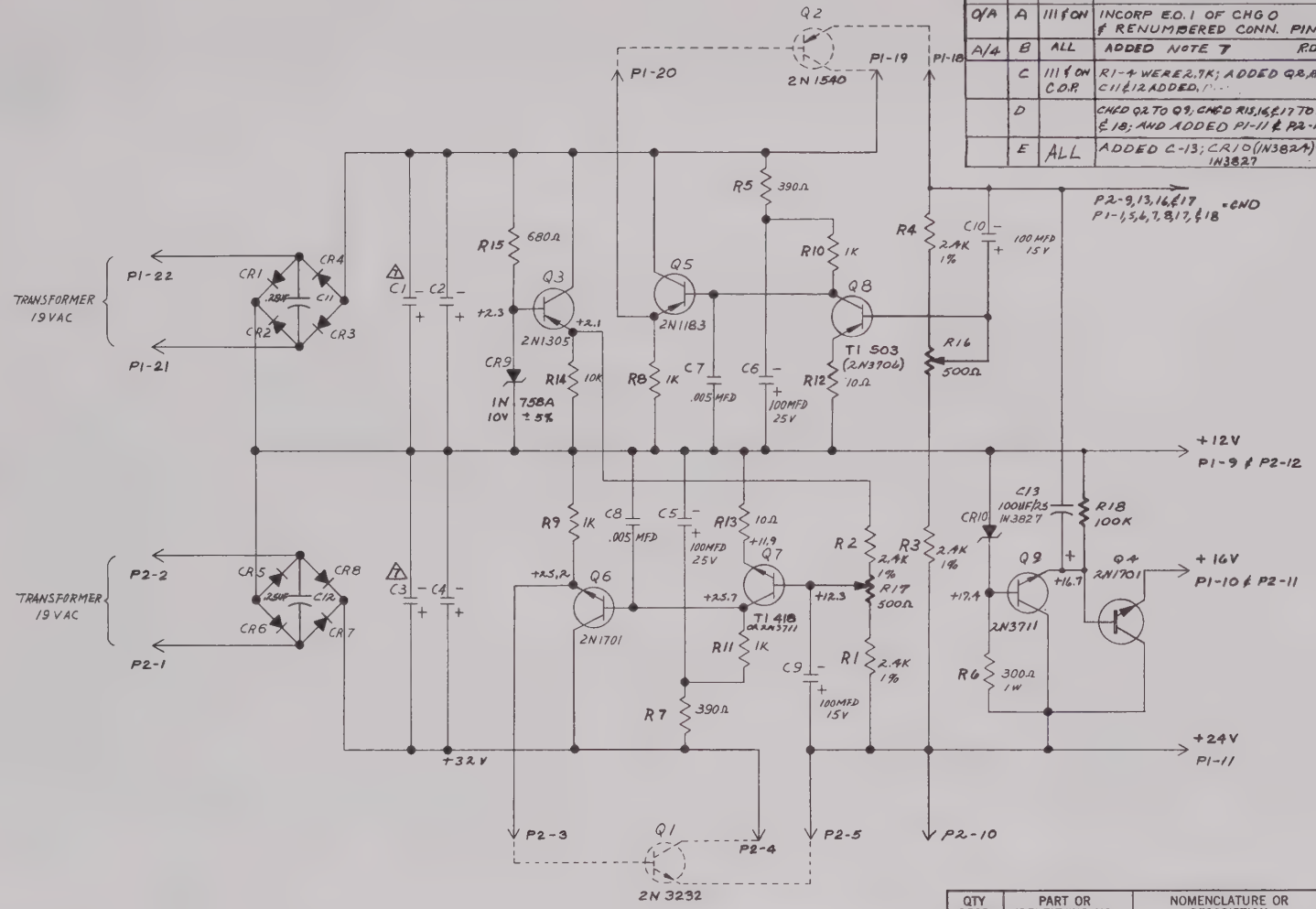
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

POWER SUPPLY ASSEMBLY

SERIES 5000

SIZE	CODE IDENT NO.	
C	03626	50-7
SCALE	WEIGHT	SHEET 2 OF 2

10/64 DIETERICH-POST CLEARPRINT 1088M-10



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
Q/A	A	111 ON	INCORP E.O. 1 OF CHG 0 & RENUMBERED CONN. PINS	5-13-65 MAT	R.T.W.
A/4	B	ALL	ADDED NOTE 7 R.O.W.	9-30-65	R.T.W.
	C	111 & ON C.O.R	R1-4 WERE 2.7K; ADDED Q8, R15, R16, & R17 C11 & 12 ADDED, [illegible]	10-15-65 JAC	R.T.W.
	D		CHGD Q2 TO Q9; CHGD R15, 16, & 17 TO R13, & 18; AND ADDED P1-11 & P2-10	10-25-65 JAC	R.T.W.
	E	ALL	ADDED C-13; CR10 (IN3824) CHGD TO IN3827	12-21-65 JAC	R.T.W.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

⚠ C1 & C3 2000 MFD/50V MAY BE USED AS AN ALTERNATE FOR C1-C4.

6. Q8 - 2N3638 TRANSISTOR MAY BE USED IN LIEU OF T1503 PROVIDED A MIN BETA OF 60 IS MAINTAINED.
5. RESISTORS ARE ½ W. CARBON 5% TOL.
4. R1 THRU R4 ARE PW1220 1% W.W.
3. Q1 AND Q2 ARE MOUNTED ON INNER CHASSIS
2. C1 THRU C4 ARE 1000 MFD/25V (SEE NOTE 7)
1. CR1 THRU CR8 ARE T14385 OR MOTOROLA IN4003

NOTES: UNLESS OTHERWISE SPECIFIED.

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
50-193	50-193	1	1
50-150	50-150	1	1
50-129	50-129	1	1
50-28	50-28	1	1
50-17	50-17	1	1
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

MATERIAL

CONTR. NO.

DRAWN	LAM	12/2/64
CHECK	[signature]	2-2-65
APPR	R. Meredith	2-2-65
RELEASE DATE	2-2-65	

NLS NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

POWER SUPPLY ASSEMBLY

SERIES 5000

SIZE	CODE IDENT NO.	
C	03626	50-7
SCALE	WEIGHT	SHEET 2 OF 2

10/64 DIETERICH-POST CLEARPRINT 1008H-10

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REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
C/7	E	ALL	R5 CHG. FROM 11.11K TO 11.111K	8-12-65 JAC	R. Knapik
B/8	F	ALL	CORRECTED SCHEMATIC ERROR	9-8-65 JAC	R. T. W.
C/12	G	ALL	P2-18 (GND) ADDED	10-8-65 JAC	R. Knapik
B/3	H	ALL	R38 DUPLICATED; ONE REVISED AS R39; ADDED RELAY NUMBERS	12-14-65 JAC	R. Knapik
B/7			INCORP. E.O. 1 ONE "B"		

P2-15 (+24 V)
P2-10 RANGE LOGIC SET
P2-16 (+16 V)
P2-1&2 (LO OUT)
P2-3&4 (HI OUT)
RELAY "2" "4" "2" "1"
P2-7&8 (REF HI IN)
P2-5&6 (LO IN)
P2-13 (ON PULSE IN)
P2-11 (UP PULSE OUT)
CR36 IN756
K1 K2 (CR31) K3 (CR30) K4 (CR29) CR28
Q24 Q23 Q22 Q21
R10 2.2K R11 2.2K R12 2.2K R13 2.2K
P2-12 (UP PULSE IN)
P2-14 (ON PULSE OUT)
P1-15 P1-19 P1-16 P1-20 P1-17 P1-21 P1-18 P1-22
P2-18 (GND)
P1-1 (0) P1-2 (1) P1-3 (2) P1-4 (3) P1-5 (4) P1-6 (5) P1-7 (6) P1-8 (7) P1-9 (8) P1-10 (9)
P2-17 (+12V)

8. P2 MATES WITH J16 J20 J24 & J28
7. P1 MATES WITH J15, J19, J23 & J27
6. RESISTORS ARE 1/2 W CARBON 5% TOL
5. DIODES ARE 5003-002
4. R1 THRU R9 ARE PW2016
3. Q21 THRU Q24 ARE 2N1304
2. Q1 THRU Q20 ARE 2N1305 (Q9-Q20 2N404A MAY SUBSTITUTE)
1. C1 THRU C8 ARE 0.01 MFD/150V

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

50-17	50-17	4	4
50-28	50-28	3	3
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

CONTR. NO.
DRAWN L. KNAPIK 4-6-65
CHECK R. T. WARNER 4-20-65
APPR C. MEREDITH 4-20-65
RELEASE DATE 4-21-65

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC DECADE ASSEMBLY

SERIES 5000

SIZE	CODE IDENT NO.	
D	03626	50-61

SCALE WEIGHT SHEET 2 OF 2

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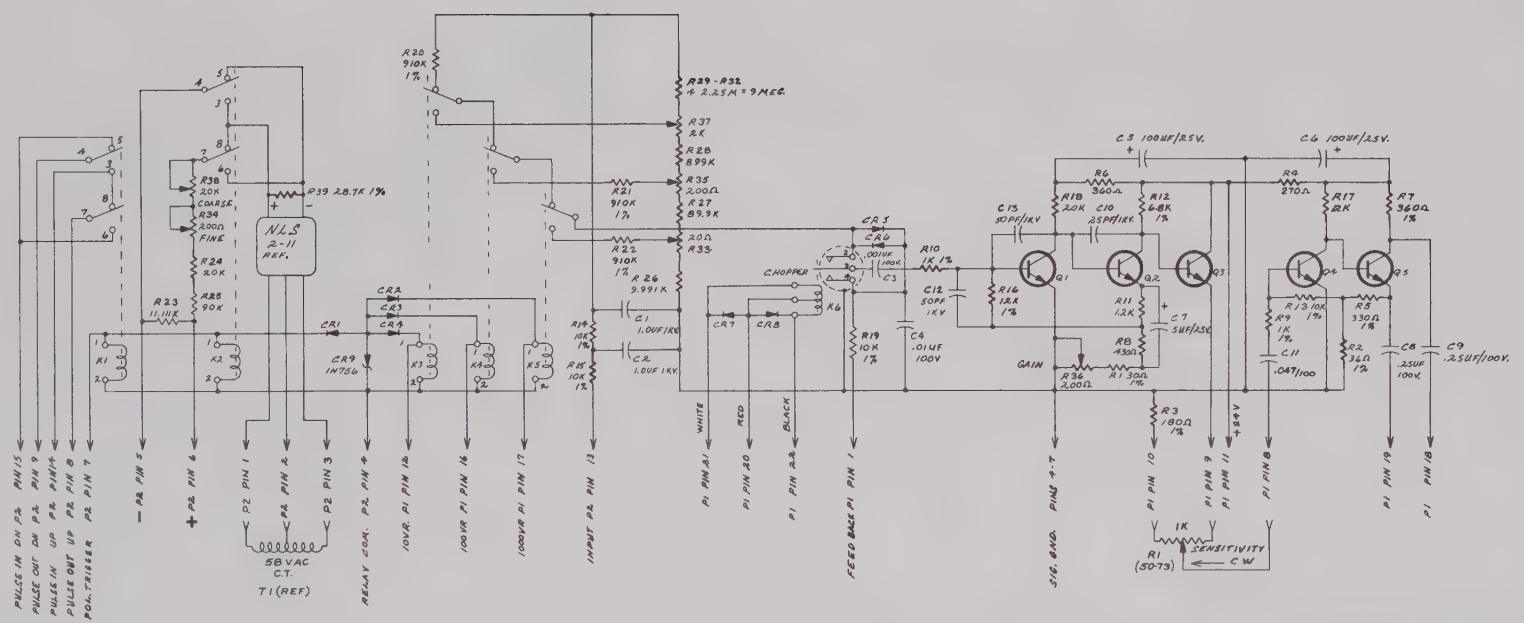
REVISIONS

SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
A			INCORP. E.O. 1 & 2 OF CHG "O"	5-20-65	R.T.W.
B			PIN 14 WIRING WAS AT PIN 10 PIN 15 WIRING WAS AT PIN 11 P2-14 CONNECTS TO K1-3 NOT 8 (INCORP. E.O. #1 CHG "A")	1965 JAN	R.T.Warner
C			INCORP. E.O. 2 OF CHG "B"	3-17-66 MAR	R. Warner



50-64 S/2 C

NOTES- 1. RESISTORS R1-R22 ARE 1/2 W 1% GENERAL PURPOSE; R23-R25 PW 1220; R26-R32 PW 2016.
2. DIODES CR1-CR8 ARE 5003-002 (UG 315).
3. ALL TRANSISTORS ARE TI 418 Q1-Q5.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.	50-28 NEXT ASSY.	50-28 FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
		PARTS LIST				APPLICATION			QTY.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS ± .010, ANGLES ± 0° 30', FRACTIONS ± 1/32
SURFACE ROUGHNESS PER MIL-STD-10
DO NOT SCALE THIS DRAWING
RELEASE DATE 4-26-65

DRAWN	J.A.COMBS	4-6-65
CHECK	[illegible]	4-27-65
APPR	R.T.Warner	4-27-65

MATERIAL
FINISH

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC

AMPLIFIER, RANGE, & POLARITY

5000 SERIES MODEL 5010

CODE IDENT NO.	SIZE	
03626	D	50-64
SCALE	WEIGHT	SHEET 2

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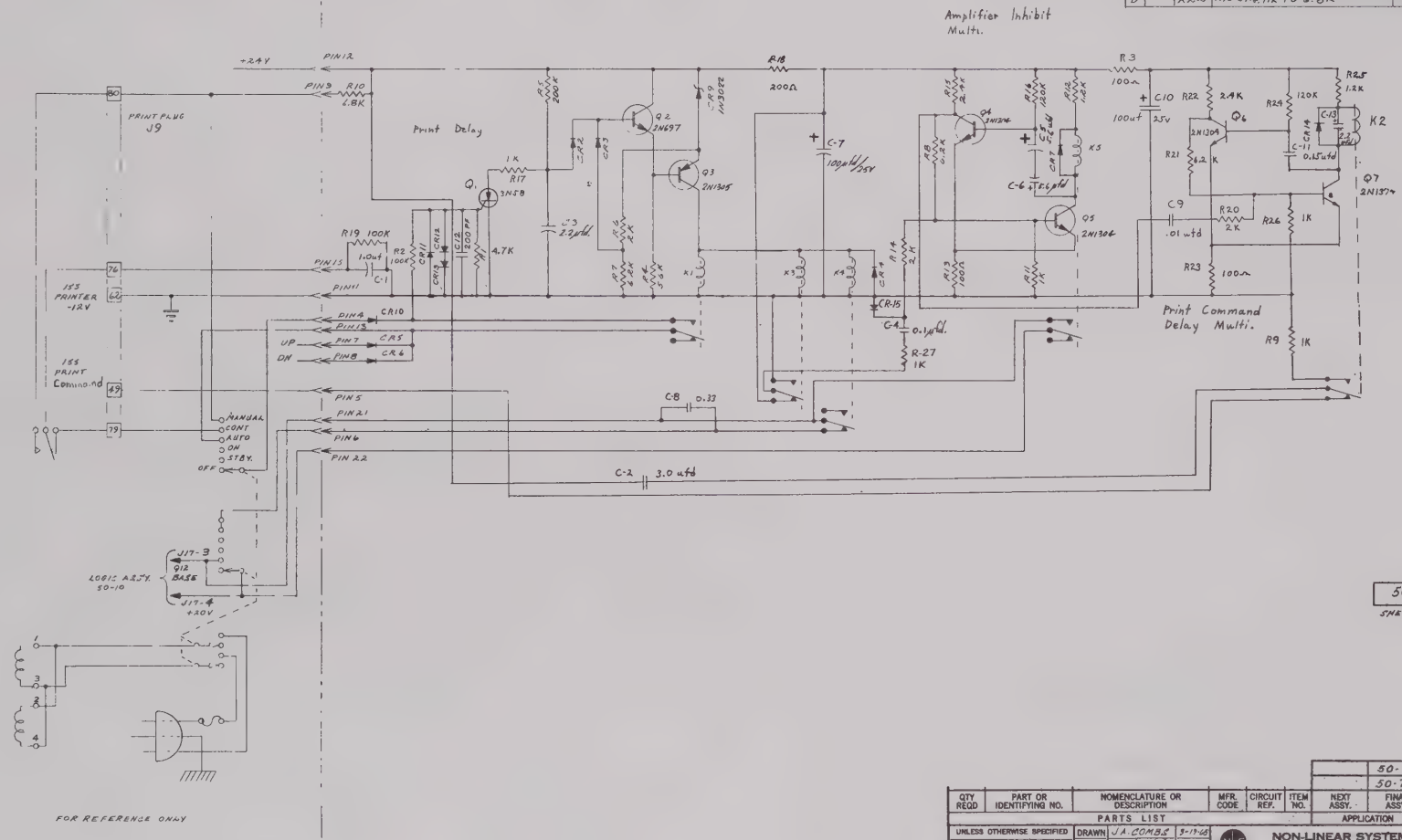
REVISIONS					
SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
A			Added Print Comm. Delay Multi. Revised Print Delay Circuit	5-5-65	R.T.W.
B		1039 ON	INCORP E.O. 1 OF CHG A	5-7-65	R.T.W.
C		ALL	INCORP. E.O. 182 OF CHG. B	9-7-65	R.T.W.
D		ALL	R10-CHG. 11K TO 6.8K	9-31-65 DAC	



50-67
SHEET 2
D

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.	NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
		PARTS LIST				APPLICATION		QTY.	
						50-79	1	1	
						50-78	1	1	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS ± .010 ANGLES ± 0° 30' FRACTIONS ± 1/32
SURFACE ROUGHNESS PER MIL-STD-10 ✓
DO NOT SCALE THIS DRAWING
RELEASE DATE 4-15-65

DRAWN	J.A. COMBS	3-19-65
CHECK	[illegible]	4-13-65
APPR	R.T. Warren	4-15-65
MATERIAL		
FINISH		

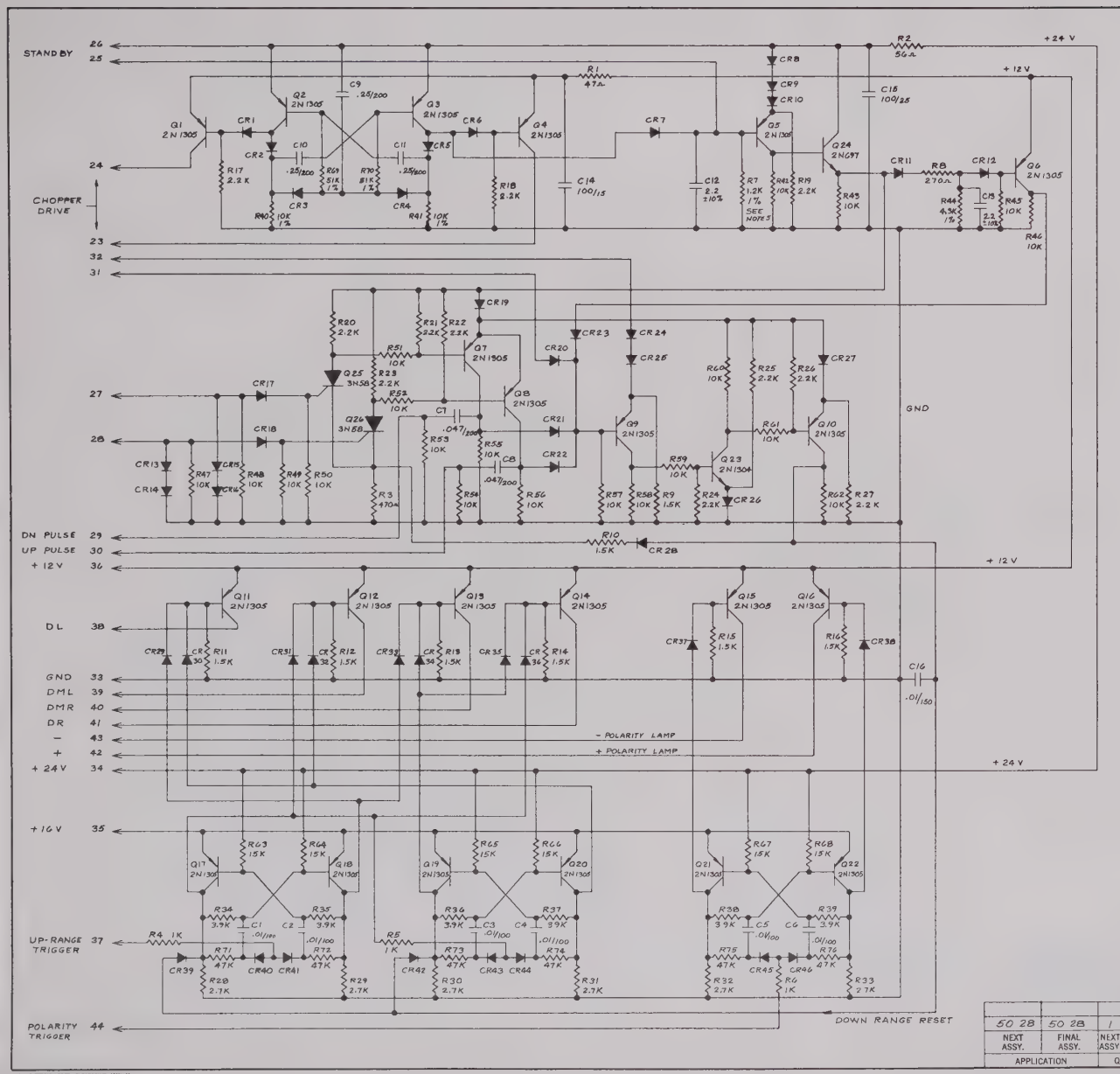
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC DVL-1 "PRINT CONTROL" BOARD

5000 SERIES

CODE IDENT NO.	SIZE	
03626	D	50-67
SCALE	WEIGHT	SHEET 2 OF 2

4. CR8 Omitted
3. ALL DIODES ARE NLS 5003-002
2. ALL RESISTORS ARE 1/2 W 5%
1. ALL RELAYS ARE NLS 5-12-34
NOTES, UNLESS OTHERWISE SPECIFIED



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A		INCORP. EO 1 & 2 OF CHG 0	5-17-65	R.T.W.
	B		INCORP. EO 1 OF CHG A	5-19-65	
2B	C	ALL	ADDED NOTE 5	7-6-65	R.T.W.

ERRATA

Pin No.'s and Designations are incorrect - See Schematic 50-72, "G" Change for correct data.

NOTES-
1. DIODES ARE TEXAS INST. UG315 (5003-002).
2. RESISTORS ARE ½W 5% OR AS NOTED.
3. CAPACITANCE VALUES ARE STATED IN MICROFARADS.
4. TRANSISTOR 2N404A MAY SUBSTITUTE FOR 2N1305 Q11 THRU Q16
5. RESISTOR R7 TO BE SELECTED DURING FINAL CHECK & CALIBRATION. NOMINAL VALUE IS 1.2K. USE DECADE RESISTANCE BOX TO SELECT PROPER VALUE PER NLS DOC. #637.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.
PARTS LIST					

50 28	50 28	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'

MATERIAL

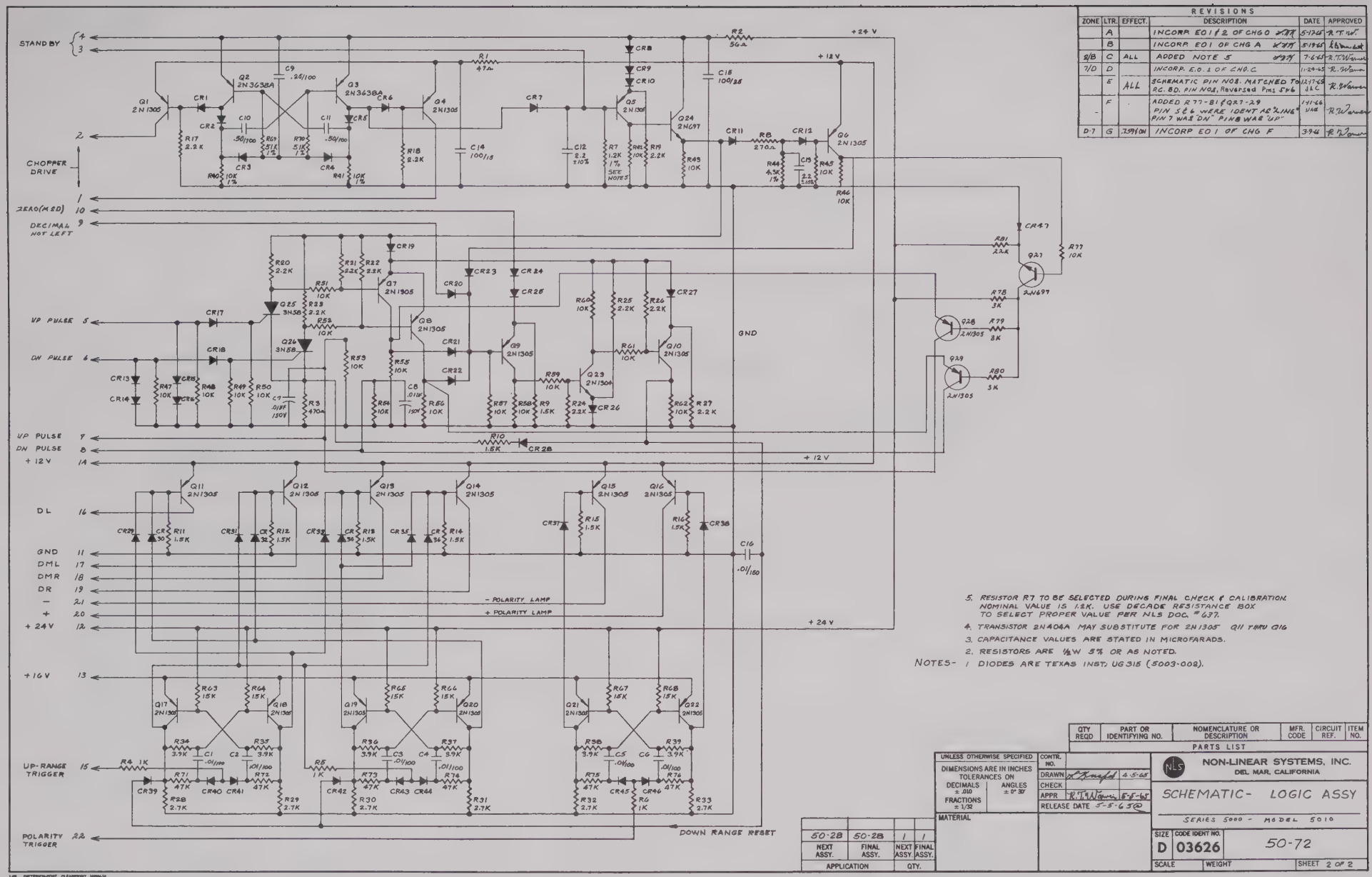
CONTR. NO.
DRAWN — 4-5-65
CHECK
APPR — 5-5-65
RELEASE DATE 5-5-65

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC- LOGIC ASSY

SERIES 5000 - MODEL 5010

SIZE	CODE IDENT NO.	
D	03626	50-72
SCALE	WEIGHT	SHEET 2 OF 2



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
	A		INCORP. EO 1 & 2 OF CHG O	5-12-65	R.T.W.
	B		INCORP EO 1 OF CHG A	5-19-65	R.T.W.
B/B	C	ALL	ADDED NOTE 5	7-6-65	R.T.W.
7/D	D		INCORP. E.O. 1 OF CHG C	11-24-65	R.T.W.
	E	ALL	SCHEMATIC PIN NOS. MATCHED TO P.C. BD. PIN NOS, Reversed Pins 5 & 6	12-17-65	R.T.W.
	F		ADDED R 77-81 & Q27-29 PIN 5 & 6 WERE IDENT AS "LINE" PIN 7 WAS "DN" PIN 8 WAS "UP"	1-11-66	R.T.W.
D-7	G	.759 ON	INCORP EO 1 OF CHG F	3-9-66	R.T.W.

NOTES-
1. DIODES ARE TEXAS INST. UG 315 (5003-002).
2. RESISTORS ARE ½W 5% OR AS NOTED.
3. CAPACITANCE VALUES ARE STATED IN MICROFARADS.
4. TRANSISTOR 2N404A MAY SUBSTITUTE FOR 2N1305 Q11 THRU Q16
5. RESISTOR R7 TO BE SELECTED DURING FINAL CHECK & CALIBRATION. NOMINAL VALUE IS 1.2K. USE DECADE RESISTANCE BOX TO SELECT PROPER VALUE PER NLS DOC. # 637.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

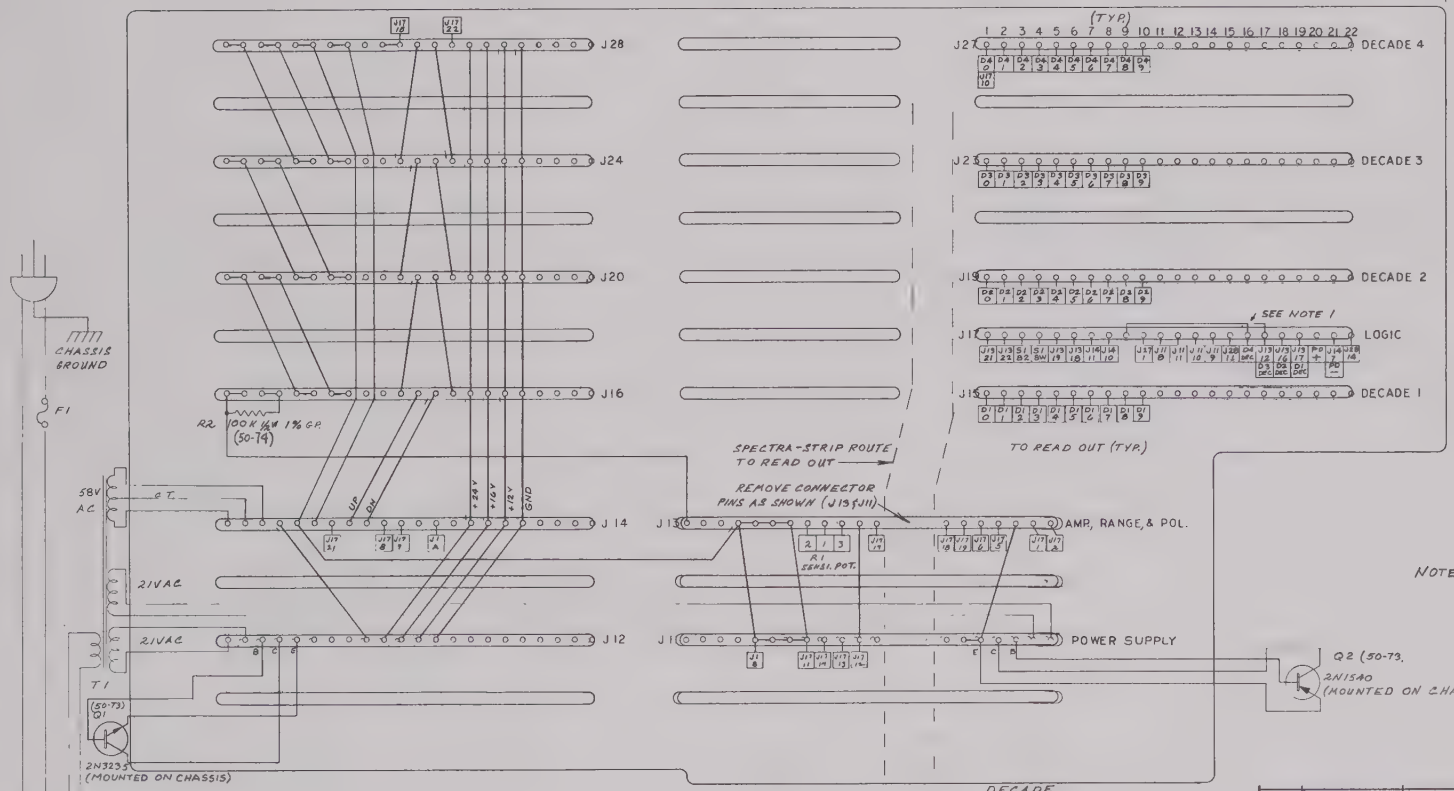
PARTS LIST

UNLESS OTHERWISE SPECIFIED	CONTR. NO.	NON-LINEAR SYSTEMS, INC. DEL MAR, CALIFORNIA
DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ± .010 FRACTIONS ± 1/32 ANGLES ± 0° 30'	DRAWN A. Kimpel 4-5-65	
	CHECK	SCHEMATIC- LOGIC ASSY
	APPR. R.T.W. 8-5-65	SERIES 5000 - MODEL 5010
MATERIAL	RELEASE DATE 5-5-65	SIZE D · CODE IDENT NO. 03626 · 50-72
		SCALE · WEIGHT · SHEET 2 OF 2

50-28 NEXT ASSY.	50-28 FINAL ASSY.	1 NEXT ASSY.	1 FINAL ASSY.
APPLICATION		QTY.	

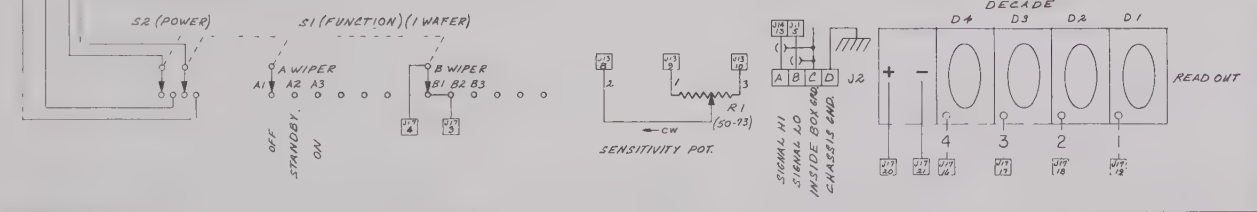
THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF NON-LINEAR SYSTEMS INC. AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT, NON-LINEAR SYSTEMS INC. RESERVES ALL PATENT, PROPRIETARY, DESIGN, USE, SALE, MANUFACTURING AND REPRODUCTION RIGHTS THERETO

REVISIONS					
SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
A		ALL	WIRE CONN. J13-1 TO J16 CHG. FROM J16-4 TO J16-1	5-4-65	RTW
B		ALL	INCORP. E.O. 1 OF CHG A	7-1-65	
C		ALL	ADDED NOTE 1		
D			INCORP. E.O. 1 & 2 OF CHG. C	2-25-66	



NOTE 1. MODEL 5010 - CONNECT J17-9 TO J17-16
MODEL 5005 - CONNECT J17-9 TO J17-17

50-74



QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.
		PARTS LIST			

50-28 | 50-28 | 1 | 1
NEXT ASSY. | FINAL ASSY. | NEXT ASSY | FINAL ASSY.
APPLICATION | QTY.

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010 | ANGLES ± 0° 30'
FRACTIONS ± 1/32
SURFACE ROUGHNESS PER MIL-STD-10 ✓
DO NOT SCALE THIS DRAWING
RELEASE DATE 4-28-65

DRAWN J.A. COMBS
CHECK L. Boogfel 4-16-65
APPR R.T. Wiener 4-27-65
MATERIAL
FINISH

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

"SCHEMATIC"
MAIN BOARD
SERIES 5000

CODE IDENT. NO. 03626 | SIZE D | 50-74
SCALE | WEIGHT | SHEET 2

DIETERICH-POST CLEARPRINT 1000H-36

THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF NON-LINEAR SYSTEMS INC., AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT, NON-LINEAR SYSTEMS INC. RESERVES ALL PATENT, PROPRIETARY, DESIGN, USE, SALE, MANUFACTURING AND REPRODUCTION RIGHTS THERETO.

REVISIONS					
SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
A		S/N. 94, 109, 114, 115 ON	ADDED CONNECTION BETWEEN J21, PIN 2 AND J9, PIN 37	6-23-64 MTS	7-7-64 T.T.W.
B		ALL	ADDED CONNECTION BETWEEN J9-11 & J17-16 (SHEET NO. CHANGED TO A)	7-22-64	T.T.W. 7-23-64
C		ALL	ADDED CONNECTION BETWEEN J9-28 & J17-14	10-29-65 JAC	

J9- 201996-1 CONNECTOR
MALE GUIDE SCREW AT 2

J9 (1)

3	
11	J17-14
17	
24	
30	
36	
42	
48	
54	
60	
67	
75	
82	

J9 (2)

7	J17-19	"DEC"
14	J15-1	"0"
21	-2	"1"
27	-3	"2"
33	-4	"3"
39	-5	"4"
45	-6	"5"
51	-7	"6"
57	-8	"7"
64	-9	"8"
72	J15-10	"9"
78	J17-14	(TYP)

J9 (3)

2	J17-18
10	J19-1
16	-2
23	-3
29	-4
35	-5
41	-6
47	-7
53	-8
59	-9
66	J19-10
74	
80	J21-9

J9 (4)

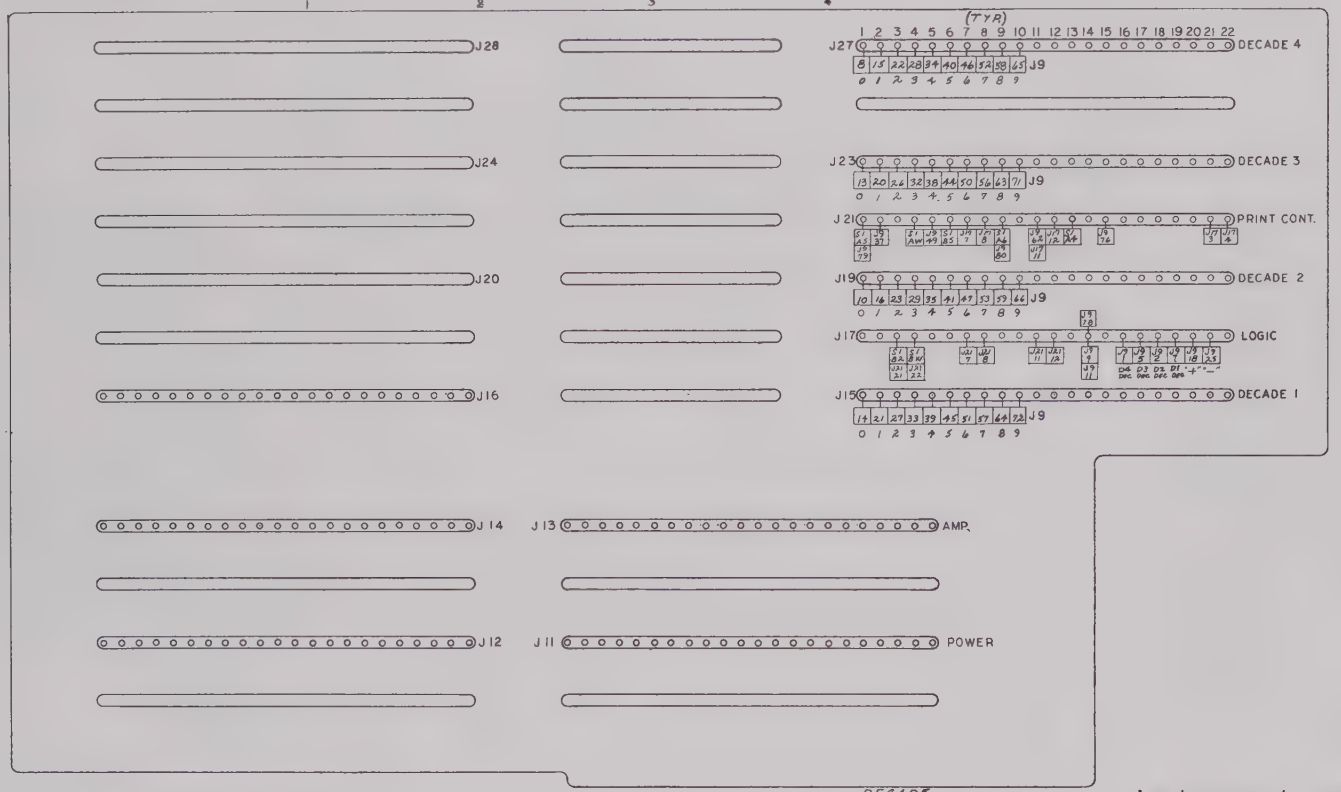
5	J17-17
13	J23-1
20	-2
26	-3
32	-4
38	-5
44	-6
50	-7
56	-8
63	-9
71	J23-10
77	

J9 (5)

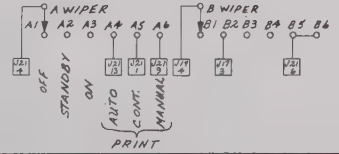
1	J17-16
8	J27-1
15	-2
22	-3
28	-4
34	-5
40	-6
46	-7
52	-8
58	-9
65	J27-10
73	
79	J21-1

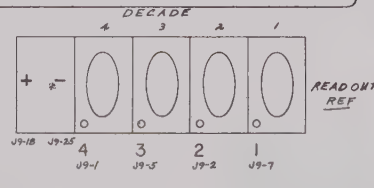
J9 (6)

4	J17-14
12	
18	J17-20 "+"
25	J17-21 "-"
31	
37	J21-2
43	
49	J21-5
55	
62	J21-11
70	
76	J21-15



S1 (FUNCTION) (1 WAFER)





50-77
C

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.	50-78 NEXT ASSY.	50-78 FINAL ASSY.	1 NEXT ASSY.	1 FINAL ASSY.
		PARTS LIST				APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010 ANGLES ± 0° 30'
FRACTIONS ± 1/32
SURFACE ROUGHNESS PER MIL-STD-10 ✓
DO NOT SCALE THIS DRAWING
RELEASE DATE 5-11-65

DRAWN J.A. COMBS 5-10-65
CHECK [signature] 5-10-65
APPR [signature] 5-11-65

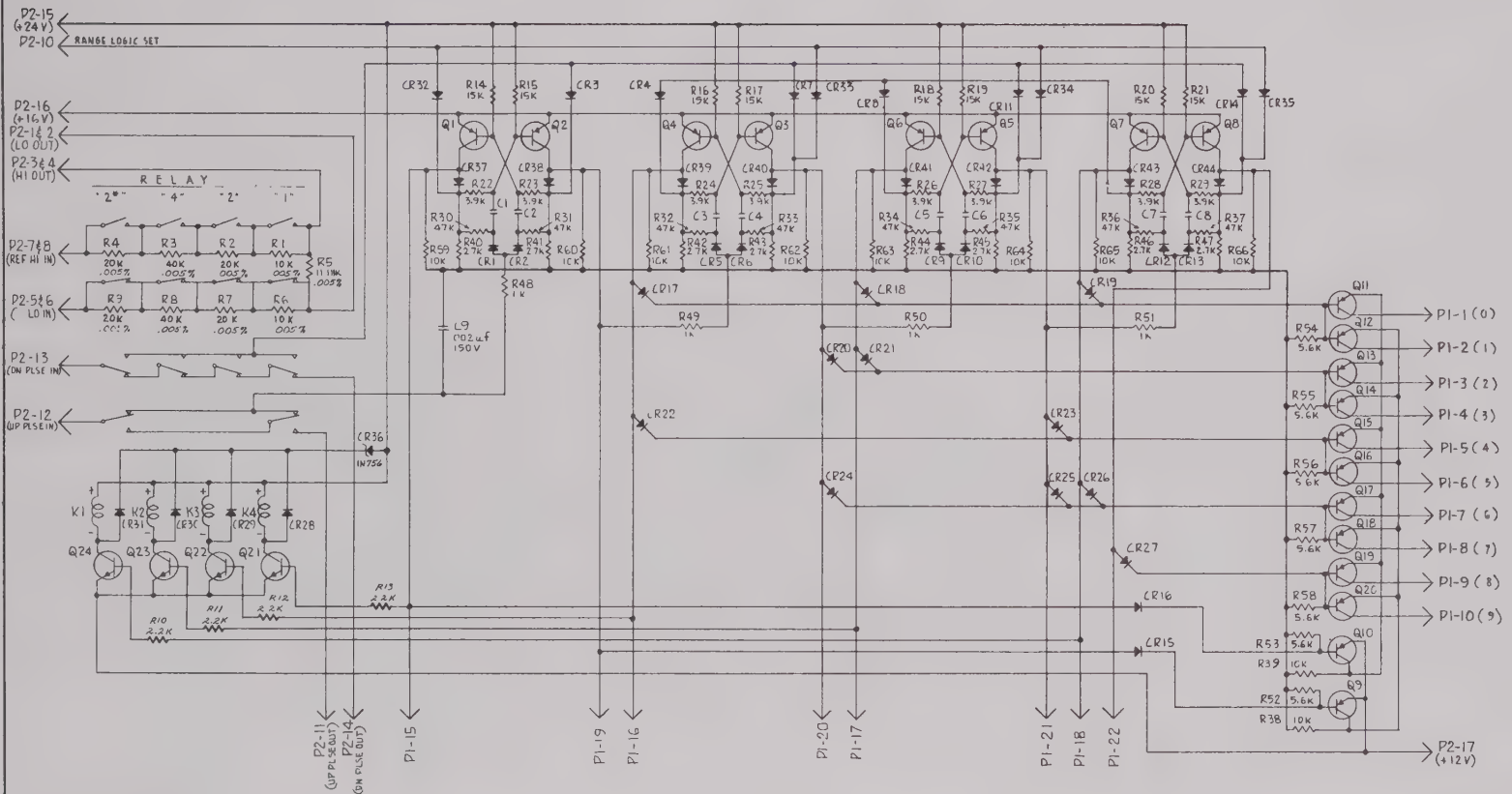
MATERIAL
FINISH

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
ADDITION FOR "DVL" PRINT CONTROL
SERIES 5000

CODE IDENT NO. 03626 SIZE D 50-77
SCALE WEIGHT SHEET 1 OF 1

REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
D/A C/9 B/B	A	ALL	REDRAWN — ADDED R55 THRU R66 & CR37 THRU CR44 R3 CHG. FROM 11.11K TO 11.111K CORRECTED SCHEMATIC ERROR	9-8-65	R.T.W.
	B	ALL	R39 WAS R38 INCORR. E.O.L. OF CHG."A"	2-11-66 JAC	2-11-66 R.T.W.



8. R1 THRU R4, R6 THRU R9: ACCURACY ±.005%, MATCHED TO .0025% TEMP COEFFICIENT 0-50 PPM, ALL IN THE SAME DIRECTION.

P2 MATES WITH J28

7. P1 MATES WITH J27
6. RESISTORS ARE ½W CARBON 5% TOL
5. DIODES ARE 5003-0012
4. R1 THRU R9 ARE PW2016
3. Q21 THRU Q24 ARE 2N1304
2. Q1 THRU Q20 ARE 2N1305 (Q9-Q20 2N404A MAY SUBSTITUTE)
1. C1 THRU C8 ARE 0.01 MFD/150V

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

50-150	50-150	1	1
50-28	50-28	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
FRACTIONS ± 1/32
ANGLES ± 0° 30'
MATERIAL

CONTR. NO.

DRAWN	L. KNAPIK	5-21-65
CHECK	R. T. WARNER	5-21-65
APPR	R. T. WARNER	5-21-65
RELEASE DATE	9-8-65	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

4TH/5TH SCHEMATIC DECADE ASSEMBLY

MODEL 5010 & 5015

SIZE	CODE IDENT NO.	
D	03626	50-114
SCALE	WEIGHT	SHEET 2 OF 2

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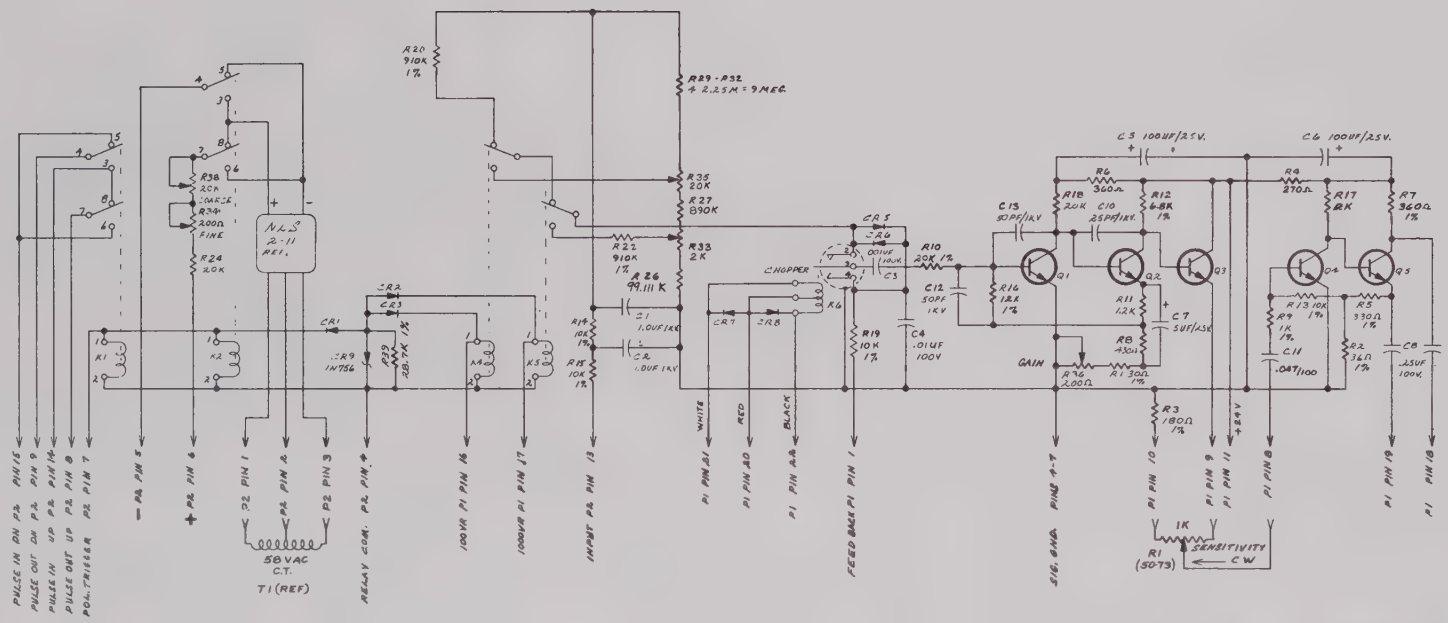
REVISIONS

SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
A		ALL	R10 GNGD TO 20K WAS 10K	5-21-65	A.T. W.
B		ALL	PIN 14 WIRING WAS AT PIN 10 PIN 15 WIRING WAS AT PIN 11 P2-14 CONNECTS TO K1-3 NOTE INCORP. E.O.I. OF CHG A	12-15-65 JAC	A.T.W.
C		ALL	ADDED R-39 - INCORP. E.O. NOTE B	2-16-66 JAC	2-17-66 A.T. W.



50-115 S/2
B

NOTES- 1. RESISTORS R1-R22 ARE 1/2W 1% GENERAL PURPOSE; R24-PW1220; R26,27, R29-R32 PW 2016.
2. DIODES CR1-3,5-8 ARE 5003-002 (UG 315).
3. ALL TRANSISTORS ARE TI 418 Q1-Q5.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.	50-17 NEXT ASSY.	50-27 FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
		PARTS LIST				APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
SURFACE ROUGHNESS PER MIL-STD-10 ✓
DO NOT SCALE THIS DRAWING
RELEASE DATE 5-20-65

DRAWN [illegible] 5-20-65
CHECK
APPR A.T. Williams 5-21-65
MATERIAL
FINISH

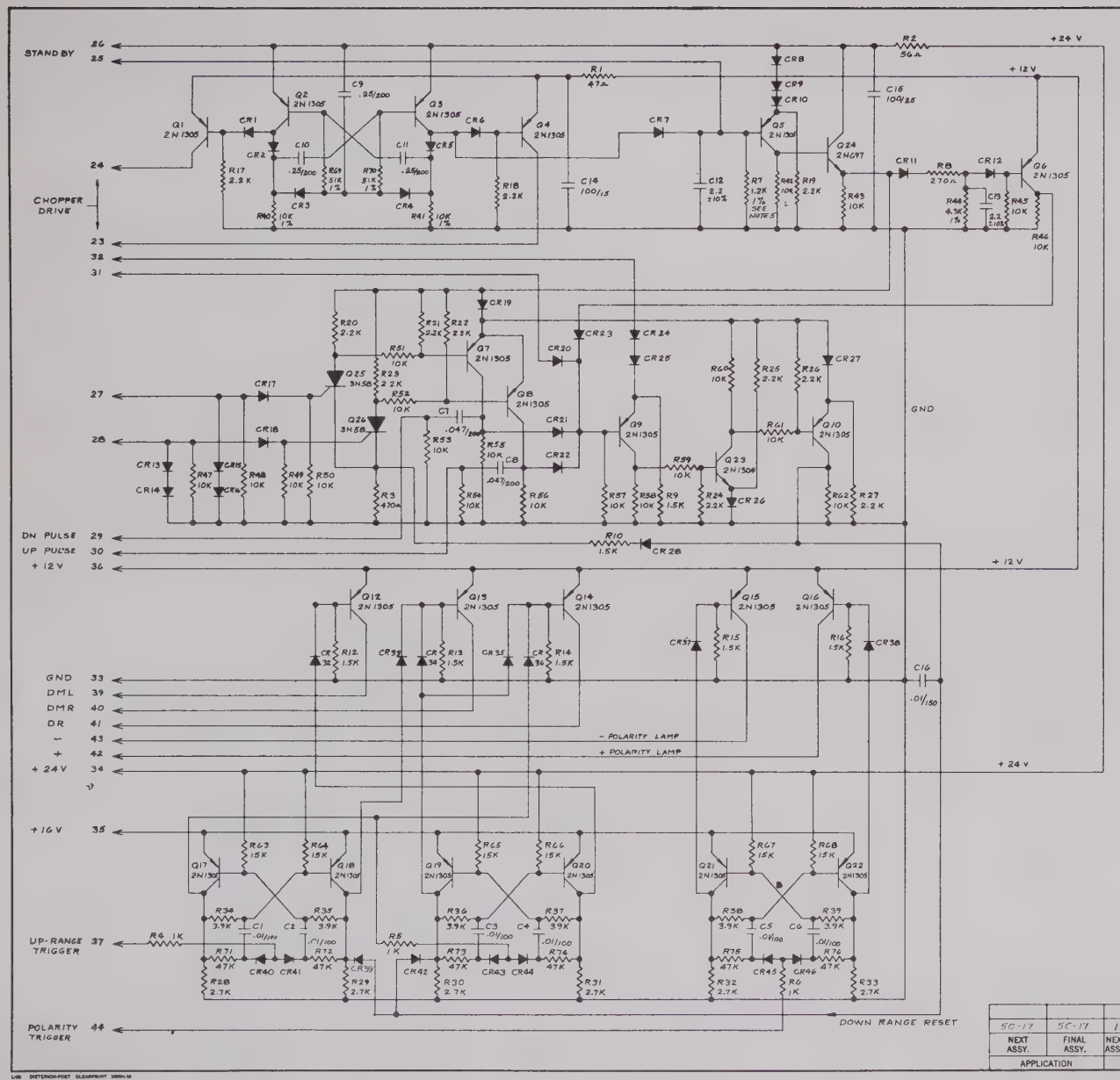
NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC

AMPLIFIER, RANGE, & POLARITY

MODEL 5005 & 5014

CODE IDENT NO.	SIZE	50-115
03626	D	
SCALE	WEIGHT	SHEET 2



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
A B D 5	A	ALL	INCORP EO 182 OF CHG'D DELETED CR 31	7-6-65	7-6-65

ERRATA

Pin No.'s and Designations are incorrect - See Schematic 50-116, "E" Change for correct data.

NOTES-
1. DIODES ARE TEXAS INST. UG 315 (5003-002).
2. RESISTORS ARE 1/2W 5% OR AS NOTED.
3. CAPACITANCE VALUES ARE STATED IN MICROFARADS.
4. TRANSISTOR 2N404A MAY SUBSTITUTE FOR 2N1305 Q12 THRU Q16
5. RESISTOR R7 TO BE SELECTED DURING FINAL CHECK & CALIBRATION. NOMINAL VALUE IS 1.2K. USE DECADE RESISTANCE BOX TO SELECT PROPER VALUE PER NLS DOC. #637.

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

50-17	50-17	1	1
NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010 ANGLES ± 0° 30'
FRACTIONS ± 1/32

CONTR. NO.
DRAWN K. Krayfel 5-19-65
CHECK
APPR R.T. Twomey 5-12-65
RELEASE DATE

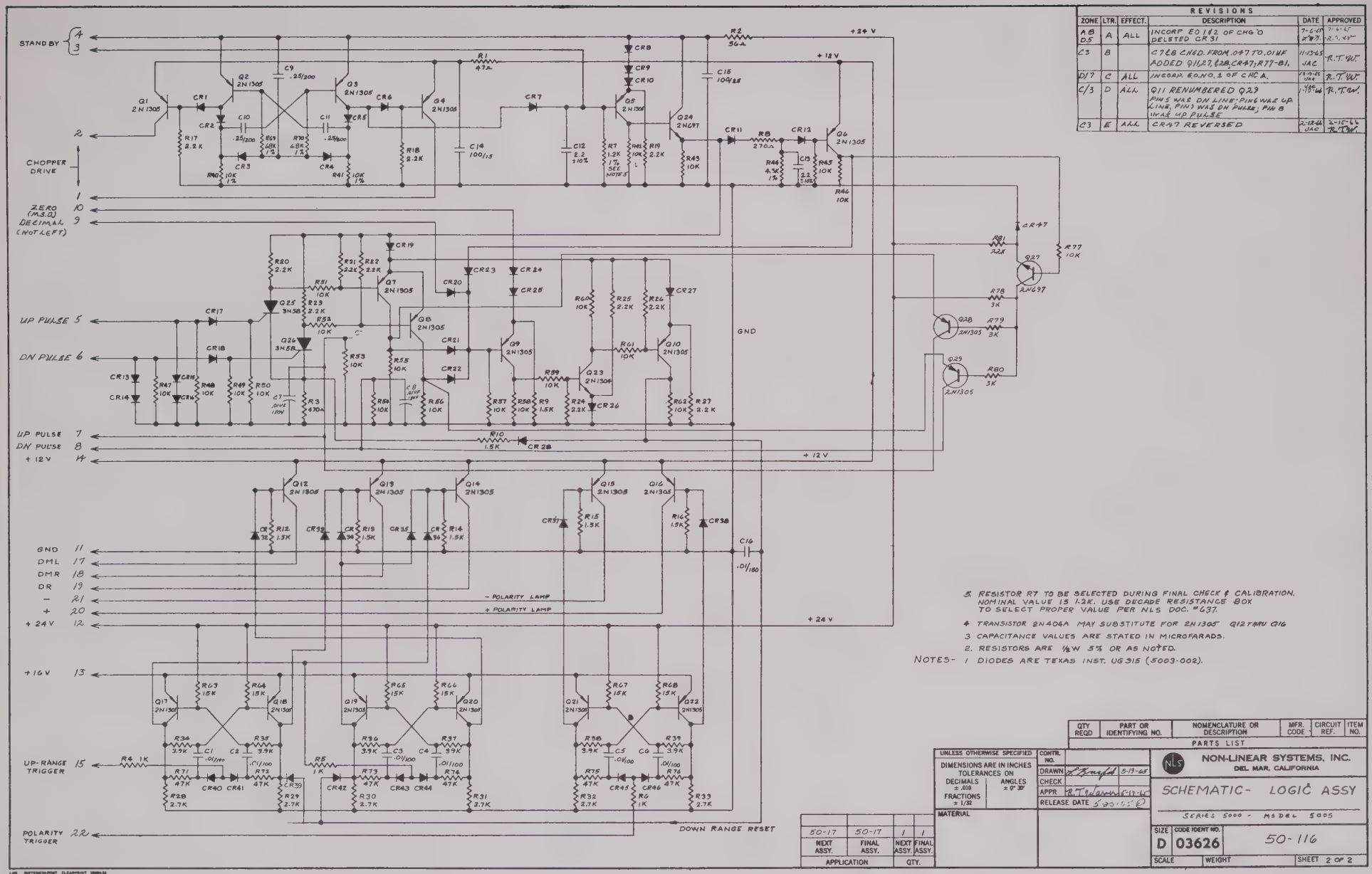
MATERIAL

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC- LOGIC ASSY

SERIES 5000 - MODEL 5005

SIZE	CODE IDENT NO.	
D	03626	50-116
SCALE	WEIGHT	SHEET 2 OF 2



REVISIONS					
ZONE	LTR.	EFFECT.	DESCRIPTION	DATE	APPROVED
A8 D5	A	ALL	INCORP EO 162 OF CHG'D DELETED CR31	7-6-65 JAC	7-6-65 R.T.W.
C3	B		C128 CHGD. FROM .047 TO .01MF ADDED Q11,27,28,CR47; R77-81.	11-13-65 JAC	R.T.W.
D17	C	ALL	INCORP. EO.NO. 1 OF CHG A.	12-9-65 JAC	R.T.W.
C3	D	ALL	Q11 RENUMBERED Q29 PIN 5 WAS ON LINE; PIN 6 WAS UP LINE, PIN 7 WAS ON PULSE; PIN 8 WAS UP PULSE	1-18-66	R.T.W.
C3	E	ALL	CR47 REVERSED	2-12-66 JAC	2-15-66 R.T.W.

5. RESISTOR R7 TO BE SELECTED DURING FINAL CHECK & CALIBRATION. NOMINAL VALUE IS 1.2K. USE DECADE RESISTANCE BOX TO SELECT PROPER VALUE PER NLS DOC. #G37.
4. TRANSISTOR 2N404A MAY SUBSTITUTE FOR 2N1305 Q12 THRU Q16
3. CAPACITANCE VALUES ARE STATED IN MICROFARADS.
2. RESISTORS ARE ½W 5% OR AS NOTED.

NOTES- 1. DIODES ARE TEXAS INST. UG315 (5003-002).

PARTS LIST

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
50-17	50-17	1	1
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32
MATERIAL

CONTR. NO.		
DRAWN	J. Kingsford	5-19-65
CHECK		
APPR	R.T.Wilkinson	5-17-66
RELEASE DATE	5-20-66	

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC- LOGIC ASSY

SERIES 5000 - MODEL 5005

SIZE	CODE IDENT NO.	
D	03626	50-116
SCALE	WEIGHT	SHEET 2 OF 2

MODIFICATION DATA

MODEL 5005 DIGITAL VOLTMETER

The Model 5005S Digital Voltmeter (P/N 50-27 - S.O. #511E054, Ad-Yu Electronics) differs from the standard Model 5005 Digital Voltmeter, described in this manual, in the following respects:

1. Fixed Range - ±9.999 VDC in the 10-volt range with the decimal point moved over so as to read ±999.9

2. < symbol is substituted for - symbol in left-most window.

3. Input Connector 97-3102A-14S-2P-426 has been removed from front panel and Input Connector 91-PC3F has been installed on rear of instrument. See Main Board Wiring Diagram, Drawing No. 50-25, for wiring connections.

4. Amplifier Assembly is 50-21 instead of 50-115. See attached Parts List and Schematic Diagram, 50-21, Sheet 2.

5. Logic Assembly is 50-22 instead of 50-116. See attached Parts List and Schematic Diagram, 50-22, Sheet 2.

6. In Chapter IV, Calibration:

   a. Under Gain Adjustment, substitute R18 for R36.

   b. Under Basic Accuracy Calibration, substitute course adjustment potentiometer R35 for R38.

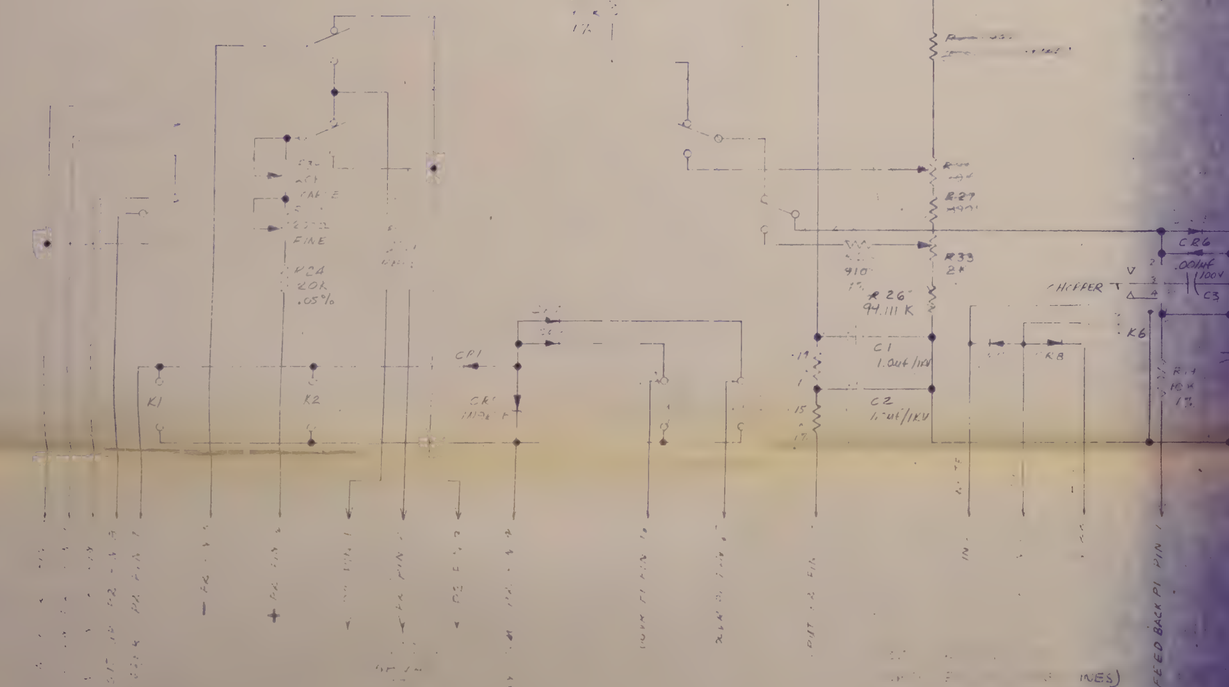
   c. Disregard all references to range calibration.

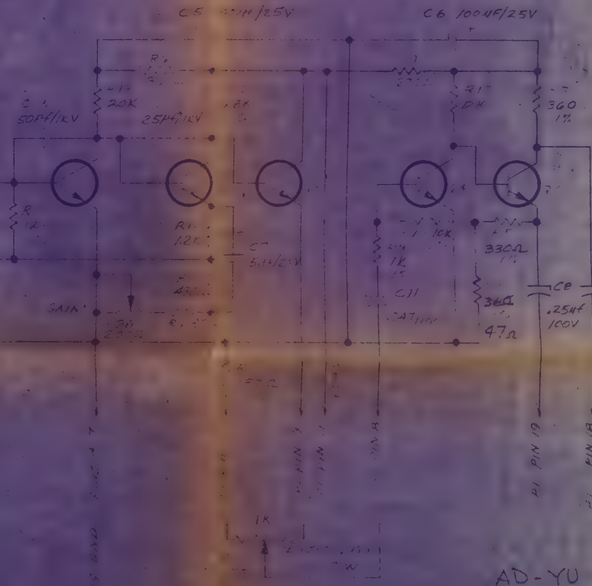
CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY. PER ASSY.	MANUFACTURER
		AMPLIFIER ASSEMBLY, P/N 50-21		
C1 & C2	ZDP1816	CAPACITOR, 1 MFD, 1000V	2	ELPAC, Inc.
C3	PD1A102K	CAPACITOR, 0.001 MFD, 100V	1	ELPAC, Inc.
C4	PD1X103	CAPACITOR, 0.01 MFD, 100V	1	Elpac, Inc.
C5 & C6	TE1211	CAPACITOR, 100 MFD, 25V	2	Sprague Prod.
C7	TE1162	CAPACITOR, 100 MFD, 15V	1	Sprague Prod.
C8 & C9	VX1X254K	CAPACITOR, 0.25 MFD, 100V	2	Elpac, Inc.
CR1 & 2	1N625	DIODE	2	
CR3, CR4 & CR7	5003-002	DIODE	3	NLS
K1	C1417-27	CHOPPER	1	The Bristol Co.
K3 & K4	12BW3G	RELAY, PRINTACT	2	Executone, Inc.
Q1, Q2 & Q5 thru Q7	2N697	TRANSISTOR	5	Texas Instruments
Q3 & Q4	T1 503	TRANSISTOR	2	Texas Instruments
R1, R2, R15 & R16	GP 1/2	RESISTOR, 10K, 1/2W, 1%	4	Texas Instruments
R6	200P-1-202	POTENTIOMETER, 2K	1	Bourns
R8	Com'l	RESISTOR, 910K, 1/2W, 5% (Carbon)	1	
R10 & R11	GP 1/2	RESISTOR, 24.3K, 1/2W, 1%	2	Texas Instruments
R12, R13, R22, R23 & R32	GP 1/2	RESISTOR, 7.5K, 1/2W, 1%	5	Texas Instruments
R14, R19 & R27	GP 1/2	RESISTOR, 200 ohms, 1/2W, 1%	3	Texas Instruments
R17	Com'l	RESISTOR, 2K, 1/2W, 5% (Carbon)	1	
R18 & R35	3067P-1-203	POTENTIOMETER, 20K	2	Bourns
R20 & R21	GP 1/2	RESISTOR, 12.1K, 1/2W, 1%	2	Texas Instruments
R25 & R26	GP 1/2	RESISTOR, 8.25K, 1/2W, 1%	2	Texas Instruments
R28	GP 1/2	RESISTOR, 3.65K, 1/2W, 1%		Texas Instruments
R29	GP 1/2	RESISTOR, 5.1K, 1/2W, 1%		Texas Instruments
R30	GP 1/2	RESISTOR, 2.43K, 1/2W, 1%		Texas Instruments
R31	GP 1/2	RESISTOR, 1.6K, 1/2W, 1%		Texas Instruments
R33	PW2016	RESISTOR, 20K, 0.1%	1	NLS
R34	3067P-1-201	POTENTIOMETER, 200 ohms	1	Bourns

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY.	MANUFACTURER
		LOGIC ASSEMBLY, P/N 50-22		
C1 & C2	ZX2X473K	CAPACITOR, 0.047 MFD, 200V	2	Elpac, Inc.
C4 thru C6	VX1X254K	CAPACITOR, 0.25 MFD, 100V	3	Elpac, Inc.
C7	CS13A F2R2M	CAPACITOR, 2.2 MFD, 35V	1	Mallory
C8	TE 1211	CAPACITOR, 100 MFD, 25V	1	Sprague Prod.
C14 & C15	DDM-103	CAPACITOR, 0.01 MFD, .150V	2	Centralab
C16	TE 1162	CAPACITOR, 100 MFD, 15V	1	Sprague Prod.
CR1 thru CR6, CR15 thru CR24, CR27, CR33, CR34 & CR45 thru CR49	5003-002	DIODE	24	NLS
Q1 & Q2	3N58	SCS	2	General Electric
Q3, Q4, Q8 thru Q12 & Q15 thru Q21	2N1305	TRANSISTOR	14	Texas Instruments
Q13	2N697	TRANSISTOR	1	Texas Instruments
R1 thru R4, R12, R13 & R32	Com'l	RESISTOR, 10K, 1/2W, 5% (Carbon)	7	
R5 & R6	Com'l	RESISTOR, 2K, 1/2W, 5% (Carbon)	2	
R7 & R9	Com'l	RESISTOR, 12K, 1/2W, 5% (Carbon)	2	
R8	Com'l	RESISTOR, 470 ohms, 1/2W, 5% (Carbon)	1	
R10, R11 & R35	Com'l	RESISTOR, 2.2K, 1/2W, 5% (Carbon)	3	
RI4, RI5, R24, R33 & R34	Com'l	RESISTOR, 5.6K, 1/2W, 5% (Carbon)	5	
R25, R69, R70 and R71	Com'l	RESISTOR, 2.7K, 1/2W, 5% (Carbon)	4	
R26 & R27	GP 1/2	RESISTOR, 10K, 1/2W, 1%	2	Texas Instruments
R28 & R29	GP 1/2	RESISTOR, 56K, 1/2W, 1%	2	Texas Instruments
R30	Com'l	RESISTOR, 47 ohms, 1/2W, 5% (Carbon)	1	
R31	Com'l	RESISTOR, 1.2K, 1/2W, 5% (Carbon)	1	
R36	Com'l	RESISTOR, 56 ohms, 1/2W, 5% (Carbon)	1	

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY PER ASSY.	MANUFACTURER
		LOGIC ASSEMBLY, P/N 50-22 (CONT)		
R40 thru R44, R65 & R66	Com'l	RESISTOR, 3.9K, 1/2W, 5% (Carbon)	7	
R63 & R64	Com'l	RESISTOR, 15K, 1/2W, 5% (Carbon)	2	
R67 & R68	Com'L	RESISTOR, 43K, 1/2W, 5% (Carbon)	2	
R72	Com'l	RESISTOR, 1K, 1/2W, 5% (Carbon)	1	
R73 & R74	Com'l	RESISTOR, 1.6K, 1/2W, 5% (Carbon)	2	

REVISIONS					
LTR	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
A		ALL	RELEASED TO X OR WAS NON	8-21-68	[illegible]
B		5-210	ACAD. OBS. REPLACE W/ UPDATED ASSY	11-5-68	R.T. 11-12-68





50-115 SH 2

AD-YU
S.O. #511E054

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.	50-27 NEXT ASSY.	50-27 FINAL ASSY.	NEXT ASSY.	FINAL ASSY.
		PARTS LIST				APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ANGLES
FRACTIONS

DRAWN
CHECK
APPR
MATERIAL
FINISH

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
AMPLIFIER, RANGE, & POLARITY
MODEL 5005 ~~5005A~~ AD-YU

CODE IDENT NO.	SIZE	DWG NO.
03626	D	50-115

SCALE | WEIGHT | SHEET

~~4. ALL DIODES ARE FDH7447 CR1, 2, 4, 5~~
3. ALL TRANSISTORS ARE TI 418 Q1-Q5.
2. DIODES CR1, 2, 4 ARE 5003-C02 (UG 313).
NOTES- 1. RESISTORS R1 THRU R25 ARE 1/2 W, 1% GENERAL PURPOSE, R2. ~~R32 PW 2 THRU R32 PW 2 THRU~~

4. ~~ALL CAPACITORS ARE PRINTED 12 PN 196 KT 2.415~~
3. ALL RESISTORS ARE T1 4.1B Q1 05.
2. [illegible] CR [illegible] ARE 50-13-022 (UG 315).

50-1[illegible]

REVISIONS			
LTR	EFFECT	DESCRIPTION	DATE
A	[illegible]	[illegible]	[illegible]
B	SIGNAL	A1A8 PC BOARD TO BE REPLACED WITH UPDATED ASSY.	[illegible]

STANDBY 26
25
CHOPPER DRIVE 24
23
32
27
28
DN PULSE 29
UP PULSE 30
+12V 36
GND 33
DML 39
DMR 40
DR 41
− 43
+ 42
+24V 34
+16V 35
UP-RANGE TRIGGER 37
POLARITY TRIGGER 44

Q1 2N1305 · Q2 2N1305 · Q3 2N1305 · Q4 2N1305 · Q5 2N1305 · Q24 2N497
CR1 · CR2 · CR3 · CR4 · CR5 · CR6 · CR7 · CR8 · CR9 · CR10
R1 47Ω · R2 100Ω · R3 470Ω · R17 2.2K · R18 2.2K · R19 2.2K · R42 10K · R47 10K 1% · R48 2K 1% · R49 6BK · R50 6BK
C9 .25/200 · C10 .25/12V · C11 .25/200 · C14 100/15 · C15 100/25 · C12 2.2 1%
R7 1.2K 1% SEE NOTE 5

Q6 2N1305 · Q7 2N1305 · Q8 2N1305 · Q9 2N1305 · Q10 2N1305 · Q11 2N1305 · Q12 2N1305 · Q13 2N1305 · Q14 2N1305 · Q15 2N1305 · Q16 2N1305 · Q17 2N1305 · Q18 2N1305 · Q19 2N1305 · Q20 2N1305 · Q21 2N1305 · Q22 2N1305
CR11 · CR12 · CR13 · CR14 · CR15 · CR16 · CR17 · CR18 · CR19 · CR20 · CR21 · CR22 · CR23 · CR24 · CR25 · CR26 · CR27 · CR28 · CR29 · CR30 · CR31 · CR32 · CR33 · CR34 · CR35 · CR36 · CR37 · CR38 · CR39 · CR40 · CR41 · CR42 · CR43 · CR44 · CR45 · CR46 · CR47 · CR48
R23 2.2K · R51 10K · R52 1.5K · R53 20K · R54 20K · R55 10K · R56 10K · R57 15K · R58 [illegible] · R59 15K · R60 [illegible] · R61 [illegible] · R62 [illegible] · R63 [illegible] · R64 [illegible] · R65 [illegible] · R66 [illegible] · R67 15K · R68 [illegible] · R69 [illegible] · R70 [illegible] · R71 [illegible] · R72 [illegible] · R73 [illegible] · R74 4.7K · R75 4.7K · R76 [illegible] · R77 2.7K · R78 2.7K · R79 [illegible] · R80 [illegible] · R81 [illegible] · R82 [illegible] · R83 [illegible] · R84 [illegible] · R85 [illegible] · R86 [illegible] · R87 [illegible] · R88 [illegible] · R89 [illegible] · R90 [illegible] · R91 [illegible] · R92 [illegible] · R93 [illegible] · R94 [illegible] · R95 [illegible] · R96 [illegible] · R97 [illegible] · R98 [illegible] · R99 [illegible] · R100 [illegible] · R101 [illegible] · R102 [illegible] · R103 [illegible] · R104 [illegible] · R105 [illegible] · R106 [illegible] · R107 [illegible] · R108 [illegible] · R109 [illegible] · R110 [illegible] 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[illegible] · R689 [illegible] · R690 [illegible] · R691 [illegible] · R692 [illegible] · R693 [illegible] · R694 [illegible] · R695 [illegible] · R696 [illegible] · R697 [illegible] · R698 [illegible] · R699 [illegible] · R700 [illegible] · R701 [illegible] · R702 [illegible] · R703 [illegible] · R704 [illegible] · R705 [illegible] · R706 [illegible] · R707 [illegible] · R708 [illegible] · R709 [illegible] · R710 [illegible] · R711 [illegible] · R712 [illegible] · R713 [illegible] · R714 [illegible] · R715 [illegible] · R716 [illegible] · R717 [illegible] · R718 [illegible] · R719 [illegible] · R720 [illegible] · R721 [illegible] · R722 [illegible] · R723 [illegible] · R724 [illegible] · R725 [illegible] · R726 [illegible] · R727 [illegible] · R728 [illegible] · R729 [illegible] · R730 [illegible] · R731 [illegible] · R732 [illegible] · R733 [illegible] · R734 [illegible] · R735 [illegible] · R736 [illegible] · R737 [illegible] · R738 [illegible] · R739 [illegible] · R740 [illegible] · R741 [illegible] · R742 [illegible] · R743 [illegible] · R744 [illegible] · R745 [illegible] · R746 [illegible] · R747 [illegible] · R748 [illegible] · R749 [illegible] · R750 [illegible] · R751 [illegible] · R752 [illegible] · R753 [illegible] · R754 [illegible] · R755 [illegible] · R756 [illegible] · R757 [illegible] · R758 [illegible] · R759 [illegible] · R760 [illegible] · R761 [illegible] · R762 [illegible] · R763 [illegible] · R764 [illegible] · R765 [illegible] · R766 [illegible] · R767 [illegible] · R768 [illegible] · R769 [illegible] · R770 [illegible] · R771 [illegible] · R772 [illegible] · R773 [illegible] · R774 [illegible] · R775 [illegible] · R776 [illegible] · R777 [illegible] · R778 [illegible] · R779 [illegible] · R780 [illegible] · R781 [illegible] · R782 [illegible] · R783 [illegible] · R784 [illegible] · R785 [illegible] · R786 [illegible] · R787 [illegible] · R788 [illegible] · R789 [illegible] · R790 [illegible] · R791 [illegible] · R792 [illegible] · R793 [illegible] · R794 [illegible] · R795 [illegible] · R796 [illegible] · R797 [illegible] · R798 [illegible] · R799 [illegible] · R800 [illegible] · R801 [illegible] · R802 [illegible] · R803 [illegible] · R804 [illegible] · R805 [illegible] · R806 [illegible] · R807 [illegible] · R808 [illegible] · R809 [illegible] · R810 [illegible] · R811 [illegible] · R812 [illegible] · R813 [illegible] · R814 [illegible] · R815 [illegible] · R816 [illegible] · R817 [illegible] · R818 [illegible] · R819 [illegible] · R820 [illegible] · R821 [illegible] · R822 [illegible] · R823 [illegible] · R824 [illegible] · R825 [illegible] · R826 [illegible] · R827 [illegible] · R828 [illegible] · R829 [illegible] · R830 [illegible] · R831 [illegible] · R832 [illegible] · R833 [illegible] · R834 [illegible] · R835 [illegible] · R836 [illegible] · R837 [illegible] · R838 [illegible] · R839 [illegible] · R840 [illegible] · R841 [illegible] · R842 [illegible] · R843 [illegible] · R844 [illegible] · R845 [illegible] · R846 [illegible] · R847 [illegible] · R848 [illegible] · R849 [illegible] · R850 [illegible] · R851 [illegible] · R852 [illegible] · R853 [illegible] · R854 [illegible] · R855 [illegible] · R856 [illegible] · R857 [illegible] · R858 [illegible] · R859 [illegible] · R860 [illegible] · R861 [illegible] · R862 [illegible] · R863 [illegible] · R864 [illegible] · R865 [illegible] · R866 [illegible] · R867 [illegible] · R868 [illegible] · R869 [illegible] · R870 [illegible] · R871 [illegible] · R872 [illegible] · R873 [illegible] · R874 [illegible] · R875 [illegible] · R876 [illegible] · R877 [illegible] · R878 [illegible] · R879 [illegible] · R880 [illegible] · R881 [illegible] · R882 [illegible] · R883 [illegible] · R884 [illegible] · R885 [illegible] · R886 [illegible] · R887 [illegible] · R888 [illegible] · R889 [illegible] · R890 [illegible] · R891 [illegible] · R892 [illegible] · R893 [illegible] · R894 [illegible] · R895 [illegible] · R896 [illegible] · R897 [illegible] · R898 [illegible] · R899 [illegible] · R900 [illegible] · R901 [illegible] · R902 [illegible] · R903 [illegible] · R904 [illegible] · R905 [illegible] · R906 [illegible] · R907 [illegible] · R908 [illegible] · R909 [illegible] · R910 [illegible] · R911 [illegible] · R912 [illegible] · R913 [illegible] · R914 [illegible] · R915 [illegible] · R916 [illegible] · R917 [illegible] · R918 [illegible] · R919 [illegible] · R920 [illegible] · R921 [illegible] · R922 [illegible] · R923 [illegible] · R924 [illegible] · R925 [illegible] · R926 [illegible] · R927 [illegible] · R928 [illegible] · R929 [illegible] · R930 [illegible] · R931 [illegible] · R932 [illegible] · R933 [illegible] · R934 [illegible] · R935 [illegible] · R936 [illegible] · R937 [illegible] · R938 [illegible] · R939 [illegible] · R940 [illegible] · R941 [illegible] · R942 [illegible] · R943 [illegible] · R944 [illegible] · R945 [illegible] · R946 [illegible] · R947 [illegible] · R948 [illegible] · R949 [illegible] · R950 [illegible] · R951 [illegible] · R952 [illegible] · R953 [illegible] · R954 [illegible] · R955 [illegible] · R956 [illegible] · R957 [illegible] · R958 [illegible] · R959 [illegible] · R960 [illegible] · R961 [illegible] · R962 [illegible] · R963 [illegible] · R964 [illegible] · R965 [illegible] · R966 [illegible] · R967 [illegible] · R968 [illegible] · R969 [illegible] · R970 [illegible] · R971 [illegible] · R972 [illegible] · R973 [illegible] · R974 [illegible] · R975 [illegible] · R976 [illegible] · R977 [illegible] · R978 [illegible] · R979 [illegible] · R980 [illegible] · R981 [illegible] · R982 [illegible] · R983 [illegible] · R984 [illegible] · R985 [illegible] · R986 [illegible] · R987 [illegible] · R988 [illegible] · R989 [illegible] · R990 [illegible] · R991 [illegible] · R992 [illegible] · R993 [illegible] · R994 [illegible] · R995 [illegible] · R996 [illegible] · R997 [illegible] · R998 [illegible] · R999 [illegible] · R1000 [illegible]

OUT

1= POLARITY LAMP
2= POLARITY LAMP

DOWN RANGE RESET

NEXT ASSY · FINAL

5. RESISTOR R7 TO BE SELECTED DURING FINAL CHECK & CALIBRATION. NOMINAL VALUE IS 1.2K. USE DECADE RESISTANCE BOX TO SELECT PROPER VALUE PER NLS DOC. #637.
4. TRANSISTOR 2N404A MAY SUBSTITUTE FOR 2N1305
3. CAPACITANCE VALUES ARE STATED IN MICROFARADS
2. RESISTORS ARE 1/2W, 5% OR AS NOTED.
1. DIODES ARE TEXAS INST. 1G315 (5003-006)

50-[illegible]
B 5116054

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR CODE	CIRCUIT REF.	ITEM NO.

PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .010
FRACTIONS
ANGLES ± 0°30'
MATERIAL

CONTR. NO.
DRAWN
CHECK
APPR
RELEASE DATE

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC- LOGIC ASSY

SIZE D · CODE IDENT NO. 03626 · 50-[illegible]

SCALE · WEIGHT

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.
1	GP ½	RESISTOR 4.3K ½W 1%	01295	R44	28
1	DDM-103	CAPACITOR .01/150V	71590	C-16	27
1	TE 1211	100UF/25V	80183	C15	26
1	TE 1162	100UF/15V	80183	C14	25
X1	CS13AF2R2M	2.2UF ±10%	06124	C12	24
3	VX1XR54K	.25UF/200V	12406	C9-11	23
2	ZX2X473K	.047UF/200V	12406	C7 & 8	22
X2	PDIJ103	CAPACITOR .01UF/100V	12406	C5-6	21
43	5005-002	DIODES	04 37-38 45-46	CR1-	20
X2	COM'L.	RESISTOR 47K ½W 5%	78488	R76-76	19
2	GP ½	51K	01295	R69 & 70	18
X2	COM'L	15K	78488	R67-68	17
20		10K		R42,43 45-66	16
X2		3.9K		R38-39	15
X2		2.7K		R28-33	14
18		2.2K	277	R17-23	13
X2		1.5K	R 12 6	R8-10 R12-16	12
1		1.2K 1%		R7	11
X1		1K		R6	10
1		470Ω		R3	9
1		100Ω 560Ω		R2	8
1	COM'L	RESISTOR 47Ω ½W 5%	78488	R1	7
X6	88006	TRANSIMOUNT	17069		6
2	3N58	SCS	24446	Q25&26	5
1	2N 697	TRANSISTOR	01295	Q24	4
1	2N 1304	TRANSISTOR	01295	Q23	3
21	2N 1305	TRANSISTOR *	01295	Q1-Q12	2
1	50-71	P/C BOARD, SUB-ASS'Y.			1

CR13-19 CR47, CR48

-47-51 R55,56

SELECT SEE SH 2.

Q1-5, 7-8, 15-16, 21, 22

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO
2	GP ½	RESISTOR 10K ½W 1%	01295	R40&41	29

50-116 2

REVISIONS

SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
A	ITEM 20	ALL	EFFECT CR31 ADDED NOTE TO R7	7-6-65	
B	ITEM 20 ITEM 16 ITEM 2	ALL	CR32-46 WAS CR32-36 45-62 WAS 44-62 NOTE WAS Q11 THRU Q16	8-6-65 R.O.W	8-6-65
C		ALL	ADDED MFG CODE, ITEMS 2-5, 7-17 & 19	8-29-65	
D		512 on	A.S.N.G. OBS. REPLACE W/UPDATED ASSY INCORPORATED E.O. 1 OF CH 6A	11-8-65	

* TRANSISTOR 2N404A MAY SUBSTITUTE FOR 2N1305 ~~Q12 THRU Q16~~ Q15&Q16.

2. SUB-ASSEMBLY 50-71

1. P/C BOARD 50-70

NOTES: UNLESS OTHERWISE SPECIFIED.

AD-YU

S.C. # 511E054

NEXT ASSY.	FINAL ASSY.	NEXT ASSY	FINAL ASSY
50-27	50-27	1	1
50-17	50-17	T	T
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

SURFACE ROUGHNESS PER MIL-STD-10 ✓

DO NOT SCALE THIS DRAWING

RELEASE DATE 5-19-65

DRAWN
CHECK
APPR

MATERIAL

FINISH

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

"ASSEMBLY"
LOGIC
SERIES 5000 AD-YU

CODE IDENT NO.	SIZE	
03626	B	50-116 2

SCALE — WEIGHT — SHEET 1 of 2

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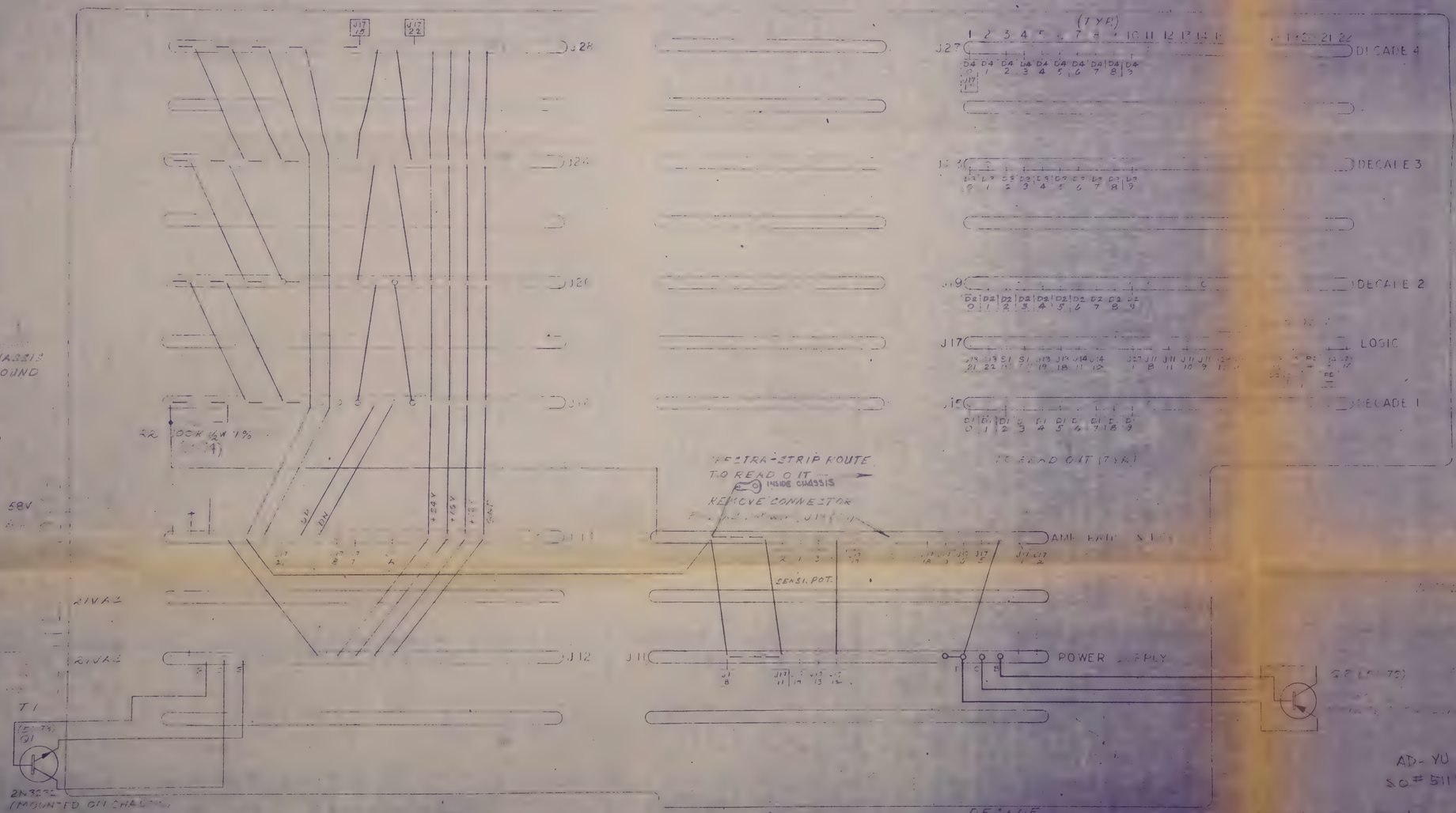
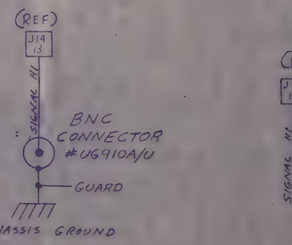
REVISIONS					
SYM	ZONE	EFFECT	DESCRIPTION	DATE	APPD
A		ALL	WIRE CONN J13-1 TO J16 CHG FROM J16-6 TO J16-1	5-4-65	R.T.H.
B		ALL	INCORP. ED. 1 OF CHG A	7-6-65	
C		ALL	ADDED NOTE 1		
B		SUPSN	ACHA OBS. REPLACE W/ UPDATED ADY	11-5-65	R.T.H.





ALTERNATE INPUT CONNECTIONS

2. SEE SL-79 SHT 1 FOR PARTS LIST.

AD-YU
SO # 511E054

QTY PER	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.	APPLICATION NEXT ASSY.	APPLICATION FINAL ASSY.	APPLICATION NEXT ASSY
		PARTS LIST				50-29	50-28	1

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ±.02, .XXX ±.005, ANGLES ±30', FRACTIONS ±1/2
SURFACE FINISHES PER MIL STD 10
BREAK ALL SHARP EDGES
DRAWN [illegible] 11-5-65
CHECK [illegible] 11-5-65
APPR [illegible] 11-5-65
MATERIAL
FINISH

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

SCHEMATIC
MAIN BOARD
SERIES 5000 AD-YU

CODE IDENT NO. 03626 | SIZE D | 50-X 85
SCALE | WEIGHT | SHT 2

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.
1	GP 1/2	RESISTOR 6.8K ½W 1%	01295	R12	28
1	"	1.2K	"	R11	27
1	"	1K	"	R9	26
1	"	430Ω	"	R8	25
2	"	360Ω	"	R6,7	24
1	"	330Ω	"	R5	23
1	"	270Ω	"	R4	22
1	"	180Ω	"	R3	21
1	"	~~36~~ 47Ω	"	R2	20
1	GP 1/2	RESISTOR 30Ω ½W 1%	01295	R1	19
5	TI 418	TRANSISTOR	01295	Q1-5	18
1	C1417-27	CHOPPER	95929	K6	17
~~X~~ 2	12 BW 3G	PRINTACT RELAY	21226	K1 ~~X5~~	16
1	IN 963B	ZENER DIODE	04713	CR9	15
~~X~~ 5	5003-002	DIODE (UG 315)	01295	~~CR1 X~~ CR2-5	14
2	RMC 1500	CAPACITOR 50 PF/1KV	91418	C12,13	13
1	DD 250	25PF/1KV	71590	C10	12
2	TE-1211	100 UF/25V	80183	C5,6	11
1	PTT-77	5 UF/25V	00656	C7	10
2	.2DP1816	1.0 UF/1KV	12436	C1,2	9
2	VX1X 254K	.25 UF/100V		C8,9	8
1	2X2X473K	.047 UF/200V		C11	7
1	PDIX103	.01 UF/100V		C4	6
1	PDIA102K	CAPACITOR .001 UF/100V	12436	C3	5
1	50-76	SHIELD			4
1	50-75	CHOPPER BRACKET			3
~~X~~ 2	50-19	BOARD, RELAY CONTACT			2
1	50-63	P/C BOARD, SUB-ASS'Y.			1

50-XE21

B

REVISIONS

SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED
B	-	519	A ENG. OBS. REPLACED WITH UPDATED ~~Y~~	11-5-73	R. T. W. 11-12
~~B~~	NEXT	ALL	~~DELETED R28 8.87K 1% 1/2W 1 PPM~~	2-14-75	
~~A~~	ITEM	ASSY	~~AS WAS ON ASSY~~	~~2-21-74~~	

QTY REQD	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MFR. CODE	CIRCUIT REF.	ITEM NO.
5"	COM'L	TEFLON TUBING - 1/8 I.D. .016 WALL			52
2	"	#4 FLWSHR			51
5	"	#4 LWSHR			50
3	"	#4-40 x 5/16 TR HD SCR PR			49
2	COM'L	#4-40 x 1/4 TR HD SCR PR			48
~~20~~ 24	5025C	TERMINAL	95264		47
1	2001-47	HEX STANDOFF			46
1	~~2-11~~ 522	REFERENCE MODULE			45
~~X~~ 1	200P-1-203	TRIMPOT 20K	80294	~~R43~~ R33	44
~~1~~	~~200P-1-202~~	~~TRIMPOT 2K~~	~~80294~~	~~R33~~	43
2	200P-1-201	TRIMPOT 200Ω	80294	R34,36	42
					41
~~4~~	~~PW 20K 22 PPM~~	~~RESISTOR 2.25M .05%~~		~~R29-32~~	40
					39
~~1~~	~~PW 20K 8.87K PPM~~	~~8.87K .05%~~		~~R27~~	38
~~1~~	~~PW 20K 39.1K PPM~~	~~39.1K .05%~~		~~R26~~	37
					36
1	PW 1220-20001M	20K .05%		R24	35
					34
~~X~~ 1	GP 1/2	RESISTOR 910K ½W 1%	01295	R20, ~~22~~	33
	"	"	"		32
2	"	20K	"	R18,10	31
2	"	12K	"	R16,17	30
4	GP 1/2	RESISTOR 10K ½W 1%	01295	R13-15, ~~19~~	29

2. SUB-ASSEMBLY ~~50-63~~ 50-63
1. P/C BOARD ~~50-62~~ 50-62

NOTES: UNLESS OTHERWISE SPECIFIED.

S.O. # 511E054

AD-YU

NEXT ASSY.	FINAL ASSY	NEXT ASSY QTY.	FINAL ASSY QTY.
50-27	50-27	1	1
~~50-17~~	~~50-17~~	+	+

APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010
ANGLES ± 0° 30'
FRACTIONS ± 1/32

SURFACE ROUGHNESS PER MIL-STD-10 ✓

DO NOT SCALE THIS DRAWING

RELEASE DATE

DRAWN
CHECK
APPR

MATERIAL

FINISH

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

"ASSEMBLY"

AMPLIFIER, RANGE & POLARITY

MODEL 5005 ~~5005A~~ AD-YU

CODE IDENT NO.	SIZE	
03626	B	50-XE21

SCALE — WEIGHT — SHEET 1 of 2

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50-17 SH 2

50-17

REVISIONS					
SYM	ZONE	EFFECT.	DESCRIPTION	DATE	APPROVED

50-7 SH 2 POWER SUPPLY ASSY

-61 SH 2 DECADE ASSY

-74 SH 2 MAIN BOARD ASSY

-115 SH 2 AMPLIFIER ASSY

-116 SH 2 LOGIC ASSY

NEXT ASSY.	FINAL ASSY.	NEXT ASSY.	FINAL ASSY
APPLICATION		QTY.	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ± .010 ANGLES ± 0° 30'
FRACTIONS ± 1/32
SURFACE ROUGHNESS PER MIL-STD-10 ✓
DO NOT SCALE THIS DRAWING
RELEASE DATE 6-7-65

DRAWN L. Bryant 6-4-65
CHECK
APPR C. Moore 6/7/65
MATERIAL
FINISH

NON-LINEAR SYSTEMS, INC.
DEL MAR, CALIFORNIA

DIGITAL VOLTMETER ASSY
SCHEMATIC LIST
SERIES 5000 Mod 5005

CODE IDENT NO.	SIZE	
03626	A	50-17
SCALE	WEIGHT	SHEET 2 OF 3

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